# INTERMEDIATE (IPC) COURSE

## STUDY MATERIAL

## PAPER : 7A

# INFORMATION TECHNOLOGY

BOARD OF STUDIES

THE INSTITUTE OF CHARTERED ACCOUNTANTS OF INDIA

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# A WORD ABOUT STUDY MATERIAL

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In this prompt shifting world of Information and Communication Technologies, the Institute felt an urgent need to revisit the syllabus of IT related papers separately and hence, the syllabus of 'Information Technology' paper has been revised with a view to rationalize the same in the light of recent technological developments by making necessary additions/deletions and modifications therein.

This paper enables students to understand how business processes are automated and explains the business implications, considerations and imperatives for practical deployment of IT in enterprises. The topics covered are closely linked with the topics covered in other papers viz. "Strategic Management" and "Audit and Assurance", which will facilitate students to understand the conceptual framework of business processes and information systems and thus assist better understanding of topics covered in the curriculum. The topics covered in this paper elucidate how business processes and information systems are inter-linked and how these can be automated using different IT components.

Students may note that the CA course is not just about understanding of theory but provides a platform for practical application of the knowledge gained, through their work as articles in the area of compliance, assurance or advisory services. The study material covered both concepts and practical aspects and hence, students are advised to read the study material not only from examination point of view but also from practical perspective of how this is relevant and can be applied to their work environment.

The overall learning objective of this paper ***"To develop understanding of Information technology as a key enabler and facilitator of implementing Information systems in enterprises and their impact on business processes and controls"*** has been kept in mind while developing the material. The learning objectives are translated into a set of task statements, which outline what the students should learn "to do". The task statements are linked to a set of knowledge statements, which outline what they should "know" to be able to perform the tasks. All these together have been used to develop the topics, which provide the detailed contents with a logical flow. Chapter-wise coverage of various topics in the study material is given as follows:

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**Chapter 2** includes the discussion on the relevance of auditing in Business Processes, the phases of System Development Life Cycle (SDLC) and overview of Information Systems layers. Overview of latest technological devices and popular computing models and architectures are also focused here.

**Chapter 3** deals with the topics on fundamentals, components and functioning of Telecommunication systems, different types of networks and their architectures. Afterwards, the chapter provides an insight on the working of internet and its different technologies.

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# STUDY PLAN – KEY TO EFFECTIVE LEARNING

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The level of knowledge required for the subject is 'Working knowledge' and the objective is '***To develop understanding of Information Technology as a key enabler and facilitator of implementing Information Systems in enterprises and their impact on business processes and controls***'. For this, students have to focus their study on fundamental comprehension of business processes; and automation of various business processes through Business Information Systems. Besides, students should also give due importance to the terms/definitions for proper conceptualization of the answers. The detailed learning objectives of the paper are given below:

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- To comprehend the topics on fundamentals, components and functioning of Telecommunication systems, different types of networks and their architectures.
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- Consequently in the second chapter, students should stress on comprehending IT fundamentals and the emerging technologies/devices helpful in automating business processes. To provide better understanding of the Information systems, the Information Systems Life Cycle is incorporated in this chapter. Further an overview of latest devices and technologies used nowadays has been incorporated in the chapter to keep you updated.
- The third chapter deals with telecommunication and networking concepts which lay a foundation for a student to comprehend working of Internet, e-commerce and m-commerce. The understanding of these concepts is the hour of need. Students may draw comparative analysis on different architectures, topologies, transmission modes after establishing the topic clarity. Also Network Security is the major concern area, so the chapter provides an overview of different security measures that can be adopted against network threats, risks and vulnerabilities.
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**C. To conclude**

Last but not the least, remember that study will not be an arduous task if it is approached with a positive attitude and pursued with interest. If you enjoy your study; your learning will be permanent and profound. Always bear in mind that your own resolution to succeed is more important than any other. Therefore, give your hundred percent and there will be no looking back.

**Best Wishes and Happy Learning!!!**

# SYLLABUS

## Paper - 7A: Information Technology (50 Marks)

**Level of Knowledge:** Working Knowledge

**Objective:** "To develop understanding of Information Technology as a key enabler and facilitator of implementing Information Systems in enterprises and their impact on business processes and controls".

**Contents**

1. **Business Process Management & IT:** Introduction to various Business processes – Accounting, Finances, Sale, Purchase etc. Business Process Automation – Benefits & Risks, Approach to mapping systems: Entity Diagrams, Data Flow Diagrams, Systems Flow diagrams, Decision Trees/tables, Accounting systems vs. Value chain automation. Information as a business asset, Impact of IT on business processes. Business Risks of failure of IT, Business Process Re-engineering

2. **Information Systems and IT Fundamentals:** Understand importance of IT in business and relevance to Audit with case studies. Understand working of computers and networks in business process automation from business information perspective. Concepts of Computing (Definition provided by ACM/IEEE and overview of related terminologies). Overview of IS Layers – Applications, DBMS, systems software, hardware, networks & links and people. Overview of Information Systems life cycle and key phases. Computing Technologies & Hardware – Servers, end points, popular computing architectures, emerging computing architectures & delivery models – example: SaaS, Cloud Computing, Mobile computing, etc., Example: Overview of latest devices/technologies – i5, Bluetooth, Tablet, Wi-Fi, Android, Touchpad, iPad, iPod, Laptop, Notebook, Smartphone, Ultra- Mobile PC etc.

3. **Telecommunication and Networks**: Fundamentals of telecommunication, Components and functions of Telecommunication Systems. Data networks – types of architecture, LAN, WAN, Wireless, private and public networks etc., Overview of computing architectures – centralized, de-centralized, mainframe, client-server, thin-thick client etc. Network Fundamentals – Components, Standards and protocols, Network risks & controls – VPN, Encryption, Secure protocols. Network administration and management – concepts and issues. How information systems are facilitated through telecommunications. How Internet works, Internet architecture, key concepts, risks and controls, e-Commerce and M-commerce technologies

4. **Business Information Systems :** Information Systems and their role in businesses, IT as a business enabler & driver – ERP, Core Banking System, CRM, SCM, HRMS, Payment Mechanisms. The relationship between organizations, information systems and business

processes, Accounting Information Systems and linkages to Operational systems, Business Reporting, MIS & IT. Organization Roles & responsibilities and table or authorities, importance of access controls, privilege controls. Specialized systems - MIS, DSS, Business Intelligence, Expert Systems, Artificial Intelligence, Knowledge Management systems etc.

5. **Business Process Automation through Application software:** Business Applications – overview and types, Business Process Automation, relevant controls and information systems. Information Processing & Delivery channels and their role in Information Systems. Key types of Application Controls and their need. Emerging concepts – Virtualization, Grid Computing, Cloud delivery model.

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## SECTION A: INFORMATION TECHNOLOGY

### CHAPTER 1 – BUSINESS PROCESS MANAGEMENT & IT



### CHAPTER 2 – INFORMATION SYSTEMS AND IT FUNDAMENTALS

## CHAPTER 3 – TELECOMMUNICATION AND NETWORKS



## CHAPTER 4 – BUSINESS INFORMATION SYSTEMS

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2. **Information Systems and IT Fundamentals:** Understand importance of IT in business and relevance to Audit with case studies. Understand working of computers and networks in business process automation from business information perspective. Concepts of Computing (Definition provided by ACM/IEEE and overview of related terminologies). Overview of IS Layers – Applications, DBMS, systems software, hardware, networks & links and people. Overview of Information Systems life cycle and key phases. Computing Technologies & Hardware – Servers, end points, popular computing architectures, emerging computing architectures & delivery models – example: SaaS, Cloud Computing, Mobile computing, etc., Example: Overview of latest devices/technologies – i5, Bluetooth, Tablet, Wi-Fi, Android, Touchpad, iPad, iPod, Laptop, Notebook, Smartphone, Ultra- Mobile PC etc.

3. **Telecommunication and Networks**: Fundamentals of telecommunication, Components and functions of Telecommunication Systems. Data networks – types of architecture, LAN, WAN, Wireless, private and public networks etc., Overview of computing architectures – centralized, de-centralized, mainframe, client-server, thin-thick client etc. Network Fundamentals – Components, Standards and protocols, Network risks & controls – VPN, Encryption, Secure protocols. Network administration and management – concepts and issues. How information systems are facilitated through telecommunications. How Internet works, Internet architecture, key concepts, risks and controls, e-Commerce and M-commerce technologies

4. **Business Information Systems :** Information Systems and their role in businesses, IT as a business enabler & driver – ERP, Core Banking System, CRM, SCM, HRMS, Payment Mechanisms. The relationship between organizations, information systems and business

processes, Accounting Information Systems and linkages to Operational systems, Business Reporting, MIS & IT. Organization Roles & responsibilities and table or authorities, importance of access controls, privilege controls. Specialized systems - MIS, DSS, Business Intelligence, Expert Systems, Artificial Intelligence, Knowledge Management systems etc.

5. **Business Process Automation through Application software:** Business Applications – overview and types, Business Process Automation, relevant controls and information systems. Information Processing & Delivery channels and their role in Information Systems. Key types of Application Controls and their need. Emerging concepts – Virtualization, Grid Computing, Cloud delivery model.

# CONTENTS

## SECTION A: INFORMATION TECHNOLOGY

## CHAPTER 3 – TELECOMMUNICATION AND NETWORKS



## CHAPTER 4 – BUSINESS INFORMATION SYSTEMS

# 1

# Business Process Management & IT

| Learning Objectives |
| --- |
| ♦ To understand the concepts of Business Process Management (BPM) and Business Process Reengineering (BPR) in bringing about integration and significant improvement in business processes; |
| ♦ To understand the different approaches used in mapping business systems and the significance of each approach; |
| ♦ To understand the impact of Information Technology (IT) on BPM and the payback achieved by implementing BPM packages; and |
| ♦ To understand benefits and risks of implementation of BPM and BPR projects. |
| **Task Statements** |
| ♦ To evaluate the BPM Principles and Practices in order to determine whether the goals of BPM exercise are achieved effectively and efficiently; |
| ♦ To determine whether the implementation of BPM is done in a structured manner following the different phases of BPM life cycle; |
| ♦ To determine whether the business strategy and operational goals have been appropriately translated into organizational, operational and implemented business process; |
| ♦ To conduct reviews to determine the appropriateness of the approach adopted in mapping systems; |
| ♦ To determine whether the re-engineered business processes have succeeded to achieve significant improvements in profits, customer-satisfaction, quality, deliveries, etc; |
| ♦ To evaluate the payback achieved by implementing an integrated BPM system in an enterprise in terms of time and cost savings; and |
| ♦ To evaluate the business risks involved in the implementation of BPM and the necessary controls to ensure success. |

| Knowledge Statements |
|---|
| ♦ Knowledge of key concepts, terms, methodologies and techniques used in Business Process Management (BPM); |
| ♦ Knowledge of the practices that are making "process thinking" a new approach to solving business problems and are relentlessly recuperating organizational performance; |
| ♦ Knowledge of key capabilities of BPM systems; |
| ♦ Knowledge of the different phases of BPM lifecycle – evaluation, design, configuration & enactment and the elements involved in BPM implementation; |
| ♦ Knowledge of classification of business processes into different levels of business process management – business strategy, operational goals, organizational business processes, operational business processes and implemented business processes; |
| ♦ Knowledge of application of BPM solution to Accounts – the study of various processing cycles involved in Accounts and integrating them using Accounts BPM solution; |
| ♦ Knowledge of different approaches to mapping systems – Entity Relationship Diagrams, Data Flow Diagrams, Systems Flow Diagrams, System Outline Charts, Decision Trees, Decision Tables, etc; |
| ♦ Knowledge of the key concepts, terms, methodologies and techniques used in Business Process Reengineering (BPR); |
| ♦ Knowledge of the impact of IT on BPM and the criteria for determining the payback achieved through implementing integrated BPM systems; and |
| ♦ Knowledge of the numerous stumbling-blocks that organizations face while implementing BPM systems and reasons for the same. |

## 1.1 Introduction

This chapter provides key concepts, terms, methodologies and techniques for implementing BPM. It provides details of how BPM implementation is done in a structured manner through different phases of a BPM life cycle. Further, it provides an overview of how to evaluate the BPM Principles and Practices so as to determine whether the goals of BPM exercise are achieved effectively and efficiently. Automation plays a major role in BPM. Hence, the need for automation and how business process automation can be achieved is also explained. With these objectives in mind, let us understand what is BPM and how does it work.

## 1.2 Overview of Business Processes

Information technology (IT) has steadily gained prominence in the management suites of large enterprises. With the advent of new business process- and internet-based technologies, we have entered a new technological world with a new process-based design and implementation framework to employ business solutions. In this new technological world, business process designers are directly involved in systems design. The closer working relationship between business process designers and IT helps to reduce the gap between the business requirement and the final deployed solution.

The key concept of Business Process Management (BPM) is the convergence of technologies with process management theories.

### 1.2.1 What is a Process?

In the systems engineering arena, a **Process** is defined as a sequence of events that uses inputs to produce outputs. This is a broad definition and can include sequences as mechanical as reading a file and transforming the file to a desired output format; to taking a customer order, filling that order, and issuing the customer invoice.

From a business perspective, a **Process** is a coordinated and standardized flow of activities performed by people or machines, which can traverse functional or departmental boundaries to achieve a business objective and creates value for internal or external customers.

### 1.2.2 What is a Business Process?

A **Business Process** consists of a set of activities that are performed in coordination in an organizational and technical environment. These activities jointly realize a business goal. Each business process is enacted by a single organization, but it may interact with business processes performed by other organizations. To manage a process-

- The first task is to **define** it. This involves defining the steps (tasks) in the process and mapping the tasks to the roles involved in the process.
- Once the process is mapped and implemented, **performance measures** can be established. Establishing measurements creates a basis to improve the process.
- The last piece of the process management definition describes the **organizational setup** that enables the standardization of and adherence to the process throughout the organization. Assigning enterprise process owners and aligning employees' performance reviews and compensation to the value creation of the processes could accomplish this.

Process management is based on a view of an organization as a system of interlinked processes which involves concerted efforts to map, improve and adhere to organizational processes. Whereas traditional organizations are composed of departments and functional stages, this definition views organizations as networks or systems of processes. Process orientation is at the core of BPM. Hence, it is important to get understand clearly the distinction between the traditional functional organization and process organization. The following table provides the distinction between functional versus process organization as discussed in the Table 1.2.1.

**Table 1.2.1: Functional versus Process Organization***

| | Functional Organization | Process Organization |
|---|---|---|
| **Work Unit** | Department | Team |
| **Key Figure** | Functional Executive | Process Owner |
| **Benefits** | Focus on functional excellence.<br><br>Easier to implement work balancing because workers have similar skills.<br><br>Clear management direction on how work should be performed. | Responsive to market requirements.<br><br>Improved communication and collaboration between different functional tasks.<br><br>Performance measurements aligned with process goals. |
| **Weaknesses** | Barrier to communication between different functions.<br>Poor handover between functions that affects customer service.<br><br>Lack of end-to-end focus to optimize organizational performance. | Duplication of functional expertise.<br><br>Inconsistency of functional performance between processes.<br>Increased operational complexity. |
| **Strategic Value** | Supports cost leadership strategy. | Supports differentiation strategy. |

As illustrated above, process enterprise holds the promise of being more responsive to market requirements, and it is suited for companies that offer differentiated products/services rather than competing on cost alone. However, organizational realignment by itself does not result in improvements. The departments that are process complete perform manufacturing processes, support tasks, and customer interfacing, whereas the departments that are traditionally functional do not perform most activities outside of the manufacturing processes.

### 1.2.3 Business Process Flow

As discussed earlier, a **Business Process** is a prescribed sequence of work steps performed in order to produce a desired result for the organization. A business process is initiated by a particular kind of event, has a well-defined beginning and end, and is usually completed in a

*"Business Process Management Systems, Strategy and Implementation", James. F Chang, Auerbach Publications, Page No. 21

relatively short period. Organizations have many different business processes such as completing a sale, purchasing raw materials, paying employees and paying vendors, etc. Each of the business processes has either a direct or indirect effect on the financial status of the organization. The number and type of business processes and how the processes are performed would vary across enterprises and is also impacted by automation. However, most of the common processes would flow a generic life cycle. Examples of key business processes pertaining to accounting, sales and purchase are explained below.

## A. Accounting

**Accounting or Book keeping** cycle covers the business processes involved in recording and processing accounting events of a company. It begins when a transaction or financial event occurs and ends with its inclusion in the financial statements.

A typical life cycle of an accounting transaction may include the following transactions as depicted in Fig. 1.2.1:

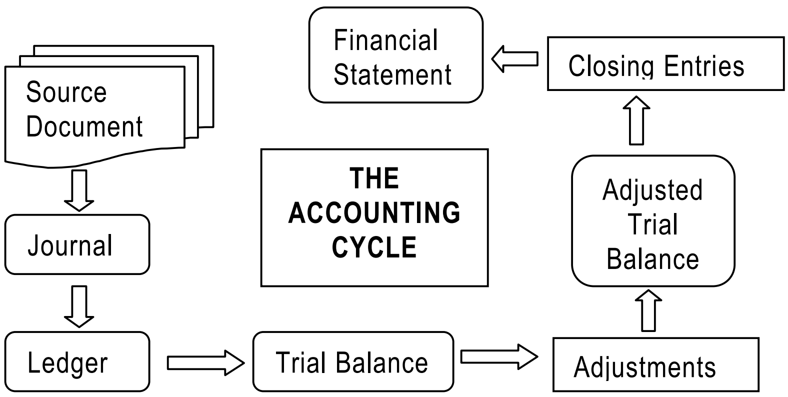


**Fig. 1.2.1: Accounting Process Flow**

(a) **Source Document:** A document that captures data from transactions and events.

(b) **Journal:** Transactions are recorded into journals from the source document.

(c) **Ledger:** Entries are posted to the ledger from the journal.

(d) **Trial Balance:** Unadjusted trial balance containing totals from all account heads is prepared.

(e) **Adjustments:** Appropriate adjustment entries are passed.

(f) **Adjusted Trial balance:** The trial balance is finalized post adjustments.

(g) **Closing Entries:** Appropriate entries are passed to transfer accounts to financial statements.

(h) **Financial statement:** The accounts are organized into the financial statements.

## B. Sales

**Order to Cash (OTC or O2C) or Sales** covers all the business processes relating to fulfilling customer requests for goods or services. It involves transactional flow of data from the initial point of documenting a customer order to the final point of collecting the cash.

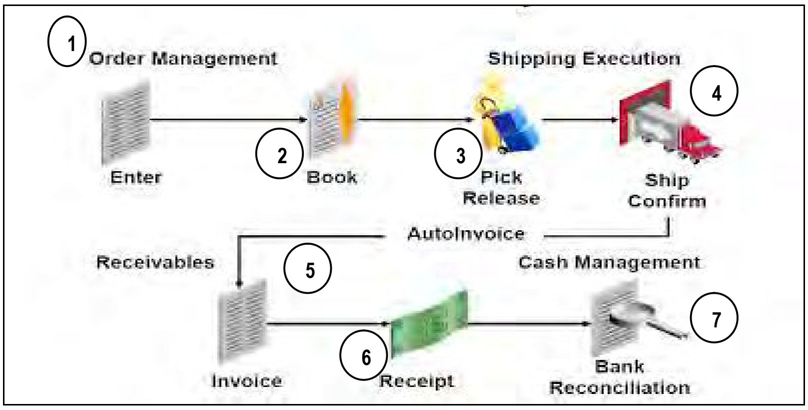


**Fig. 1.2.2: Order to cash process flow**

The typical life cycle of a sales transaction which may include the following transactions are depicted in Fig. 1.2.2 given here:

(i) **Customer Order:** A purchase order is received from a customer specifying the type, quantity and agreed prices for products.

(ii) **Recording:** Availability of the items is checked and customer order is booked.

(iii) **Pick release:** The items are moved from the warehouse to the staging area.

(iv) **Shipping:** The items are loaded onto the carrier for transport to the customer.

(v) **Invoice:** Invoice of the transaction is generated and sent to the customer.

(vi) **Receipt:** Money is received from the customer against the invoices.

(vii) **Reconciliation:** The bank reconciliation of all the receipts is performed.

## C. Purchase

**Procure to Pay (Purchase to Pay or P2P)** cycle covers all the business processes relating to obtaining raw materials required for production of a product or for providing a service. It involves the transactional flow of data form the point of placing an order with a vendor to the point of payment to the vendor.

Typical life cycles of a purchase transaction which may include the following transactions are depicted in Fig. 1.2.3.

(a) **Purchase requisition:** A document is prepared requesting the purchase department to place an order with the vendor specifying the quantity and time frame.

(b) **Request for quote:** An invitation is sent to the vendors to join a bidding process for specific products.

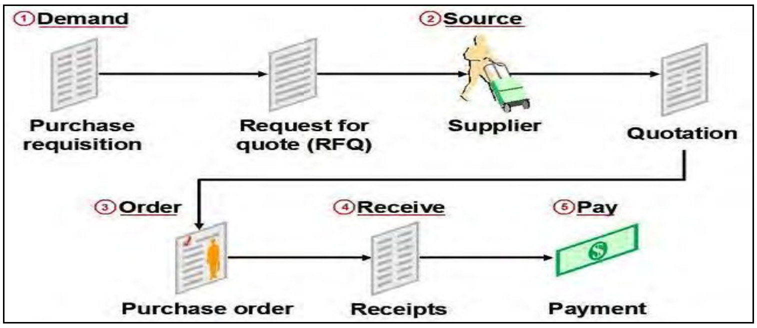


**Fig. 1.2.3: Procure to Pay Process flow**

(c) **Quotation:** The vendors provide cost quotations for the supply of products.

(d) **Purchase order:** A commercial document is issued to the vendor specifying the type, quantity and agreed prices for products.

(e) **Receipts:** The physical receipt of goods and invoices.

(f) **Payments:** The payments are made against the invoices.

## D. Finances

Finance is one of the most important and limited resources available with government. Its proper use can help target areas of need, bring in efficiency and improve services. For us, helping governments and their agencies use their funds better is one of the tenets of good governance – bringing in efficient systems and accountability in management of the limited public resource.

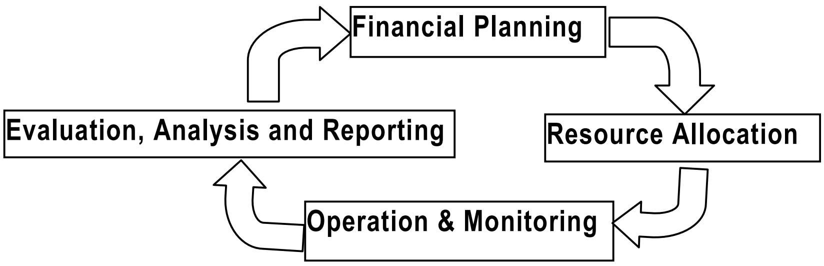


**Fig. 1.2.4: Financial Management Life Cycle**

Specialized team of professionals work in all aspects of the financial management cycle (shown in the Fig. 1.2.4) and help to reinforce economic and financial management through fiscal discipline and financial integrity. From the financial planning stage to resource allocation, monitoring and analysis, at every step of the way, governments and agencies ensure that public resources are used effectively and reach the intended beneficiaries.

## 1.3 Classification of Business Processes

Business processes are pervasive in any organization and represent all activities that an organization undertakes. Businesses try to improve on these operations or processes as a process improvement project. This requires using advanced methodologies and technologies to deliver consistent, repeatable, and more efficient outcomes by the improvement project. BPM helps to define and manage the business processes to reach the desired goals.

Business processes are broadly classified into two categories. These are as follows:

1. 'Organizational' Business Processes and
2. 'Operational' Business Processes.

Different levels can be identified in business process management, ranging from high-level business strategies to implemented business processes. These levels are depicted in Fig. 1.3.1 and are explained here.

**A. Business Strategy:** At the highest level, the **strategy** of the company is specified, which describes its long-term concepts to develop a sustainable competitive advantage in the market. An example of a business strategy is cost leadership for products in a certain domain.

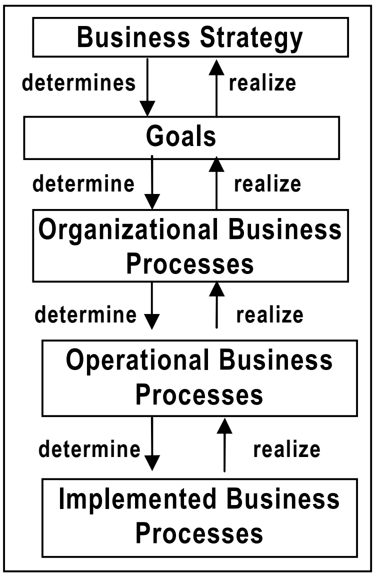


**Fig. 1.3.1: Levels of Business Processes: from business strategy to implemented business processes***

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*"Business Process Management, Concepts, Languages and Architectures", Mathias M Weske, Springer, Page No. 18

**B. Goals:** At the second level, the business strategy is broken down to **Operational Goals**. These goals can be organized, so that each goal can be divided into a set of sub-goals. Reducing the cost for supplied materials is a sample goal that contributes to the realization of the business strategy mentioned.

**C. Organizational Business Processes: Organizational business processes** are high-level processes that are typically specified in textual form by their inputs, their outputs, their expected results and their dependencies on other organizational business processes. These business processes act as supplier or consumer processes. To manage incoming raw materials provided by a set of suppliers is an example of an organizational business process.

While organizational business processes characterize coarse-grained business functionality, there are multiple operational business processes that contribute to one organizational business process.

**D. Operational Business Processes:** In **Operational Business Processes**, the activities and their relationships are specified, but implementation aspects of the business process are disregarded. Operational business processes are specified by business process models. These are the basis for developing implemented business processes.

**E. Implemented Business Processes: Implemented Business Processes** contain information on the execution of the process activities and the technical and organizational environment in which they will be executed.

## 1.4 Business Process Management

**Business Process Management (BPM)** refers to the closed loop, iterative management of business processes over their complete lifecycle. In simple terms, BPM is about the management of business processes with the organization being the primary focus. It is the methodology used by enterprises to improve end-to-end business processes in various stages and aim to grow revenues quickly while controlling resource costs.

BPM may be defined as: "**The achievement of an organization's objectives through the improvement, management and control of essential business processes**". All the key terms of the definition are explained below.

- **Achievement:** Realizing the strategic objectives as outlined in the organization's strategic plan. At a project level, it is about realizing the value or business benefits as outlined in the project business case.
- **Organization:** The organization in this context refers to an enterprise or parts of an enterprise, perhaps a business unit that is discrete in its own right. It is the end-to-end business processes associated with this part of an organization. This end-to-end focus will ensure that a silo approach does not develop.
- **Objectives:** The objectives of a BPM implementation range from the strategic goals of the organization through to the individual process goals. It is about achieving the

business outcomes or objectives. BPM is not an objective in itself, but rather a means to achieving an objective. It is not 'a solution looking for a problem'.

- **Improvement:** It is about making the business processes more efficient and effective.
- **Management:** It refers to the process and people - performance measurement and management. It is about organizing all the essential components and subcomponents for a processes. By this we mean arranging the people, their skills, motivation, performance measures, rewards, the processes themselves and the structure and systems necessary to support a process.
- **Control:** It has been said that BPM is about managing our end-to-end business processes and involves the full cycle of plan–do–check–act. An essential component of control is to have the ability to measure correctly. If we cannot measure something, we cannot control and manage it.
- **Essential:** Not every process in an organization contributes towards the achievement of the organization's strategic objectives. Essential processes are the ones that do.
- **Business:** An implementation of BPM must have an impact on the business by delivering benefits. It should focus on the core business processes that are essential to our primary business activity – those processes that contribute towards the achievement of the strategic objectives of the organization.
- **Processes:** A process comprises all the things we do to provide someone who cares with what they expect to receive. The lifecycle of an end-to-end process is from the original trigger for the process to the ultimate stakeholder satisfaction. The final test of a process's completeness is whether the process delivers a clear product or service to an external stakeholder or another internal process.

Therefore, we may say that BPM evaluates the efficacy and usefulness of business processes for reducing costs and ensure value creation. It includes concepts, methods, and techniques to support the design, administration, configuration, enactment, and analysis of business processes. The basis of BPM is the explicit representation of business processes with their activities and the execution constraints between them. Once business processes are defined, they can be subject to analysis, improvement, and enactment. A Business Process Management System (BPMS) is a generic software system that is driven by explicit process representations to coordinate the enactment of business processes. BPM is at the core of enterprises which aim to grow revenues quickly while controlling resource costs. The primary benefit of using technology for BPM are –

(i) the effectiveness gains for enterprises through the automated coordination of activities;

(ii) distribution of tasks to process participants and the amalgamation of applications; and

(iii) creation of basic operational value proposition – which is the ability to process more with less effort and higher quality.

### 1.4.1 Business Process Management Principles and Practices

The primary goal of BPM is to improve products and services through structured approach to performance improvement that centers on systematic design and management of a company's business processes. Let us understand some of the key BPM principles and practices. The BPM principles and Practices are summarized in the Table 1.4.1 given below:

**BPM's Principles**

1. BPM's first principle is **processes are assets** that create value for customers. They are to be managed and continuously improved. Because processes are assets, core processes and processes that generate the most value to customers should be carefully managed.
2. A managed process produces consistent **value to customers** and has the foundation for the process to be improved. Management of processes entails the tasks of measuring, monitoring, controlling, and analyzing business processes. Measuring of business processes provides information regarding these business processes. Process information allows organizations to predict, recognize, and diagnose process deficiencies, and it suggests the direction of future improvements.
3. The third principle is **continuous improvement** of processes. This is a natural result of process management. Process improvement is facilitated by the availability of process information. The business environment usually dictates that organizations need to improve to stay competitive. Business processes are central to an organization's value creation. It follows that processes should be continuously improved.

**Table 1.4.1: BPM Principles and Practices***

| | |
|---|---|
| **Principles** | ▪ Business processes are organizational assets that are central to creating value for customers;<br>▪ By measuring, monitoring, controlling, and analyzing business processes, a company can deliver consistent value to customers;<br>▪ As the basis for process improvement - business processes should be continuously improved; and<br>▪ Information technology is an essential enabler for BPM. |

* "Business Process Management Systems, Strategy and Implementation", James. F Chang, Auerbach Publications, Page No. 31

| | |
|---|---|
| **Practices** | ▪ Strive for process-oriented organizational structure;<br>▪ Appoint process owners;<br>▪ Senior management needs to commit and drive BPM and execution of BPM process improvements should take a bottom-up approach;<br>▪ Put in place information technology systems to monitor, control, analyze, and improve processes;<br>▪ Work collaboratively with business partners on cross-organizational business processes;<br>▪ Continuously train the workforce and continuously improve business processes;<br>▪ Align employee bonuses and rewards to business process performance;<br>▪ Utilize both incremental (e.g., Six Sigma) and more radical (e.g., BPR) methodologies to implement process improvement |

**BPM's Practices**

1. **Process-oriented organizational structure**: Processes are the core assets of an organization, and they produce the values that justify an organization's existence. In order for processes to be effectively managed and improved, BPM identifies three types of process-oriented structures:
   (a) Process Organization - This aligns the organizational structure along process lines. Each process unit would contain various functions that support the process. The advantage of process organization is that it optimizes the performance of the process.
   (b) Case management organization - In this organizational structure, employees would still report to functional heads. In addition, they would report to case managers. The case manager has the responsibility to oversee the end-to-end process of an individual case.
   (c) Horizontal process management organization - The organization would create process owners who are responsible for core processes. The core processes could be order-to-cash, product development, purchase-to-pay, etc.
2. **Appoint Process Owners**: The process owners are assigned to the core processes who are responsible for the performance of the process assigned. The process owner designs, deploys, and improves the process and is responsible for influencing functional workers and functional heads on how best to perform functions associated with the process. The process owner should be a senior member of the organization who has the power to influence other senior managers.

3. **Top-Down Commitment, Bottom - Up Execution**: In order for BPM to work, top management needs to commit to it and support the process-focused management approach it requires. Undoubtedly, organizations adopting BPM will go through difficulties and oppositions. Without top management commitment, BPM will likely to disappear because of internal organizational resistance. Executing process improvement should use a bottom-up approach. The benefit of a bottom-up approach is it encounters less resistance from the employees most directly affected by the change.
4. **Use Information Technology (IT) to Manage Processes**: BPMS aligns the IT solution to be more in line with the process and once implemented, allows organizations to measure, monitor, control, and analyze processes real time.
5. **Collaborate with Business Partners**: Increasingly companies are getting more and more focused on what they want to perform in house and what to be outsourced. Thus, it is necessary to extend process management outside the enterprise that involves sharing information with business partners and helping business partners with their business processes.
6. **Continuous Learning and Process Improvement**: In the BPM world, employees will be introduced to new technologies and work activities. In a process-focused environment, workers belong to processes and they can be expected to perform broader sets of tasks than in traditional functional organizations. The broadening of tasks workers are expected to perform and new technologies that are implemented to support BPM require workers to be up to date on their skills and knowledge. BPM organizations thrive on continuous improvement.
7. **Align Employee Rewards to Process Performance**: In the BPM organization, delivering customer value and optimizing process performance are two central goals. When employee rewards are aligned to process performance, they further collaborate among workers who are engaged in the same process in order to increase the business process performance.
8. **Utilize BPR, TQM, and Other Process Improvement Tools**: Many business process experts describe BPM as the convergence of business process improvement approaches. Under the BPM approach, the previous process-focused business improvement approaches could be seen as tools for improving the processes. For example - Six Sigma (Define, Measure, Analysis, Improve, and Control (DMAIC)) could be deployed for incremental improvements.

### 1.4.2 Business Process Management Life Cycle

**BPM Life Cycle (BPM-L Cycle)**: An Enterprise Resource Planning (ERP) application divides BPM into the following phases:

(i) **Analysis phase**: This involves analysis of the current environment and current processes, identification of needs and definition of requirements.

(ii) **Design phase**: This involves evaluation of potential solutions to meet the identified needs, business process designing and business process modeling.

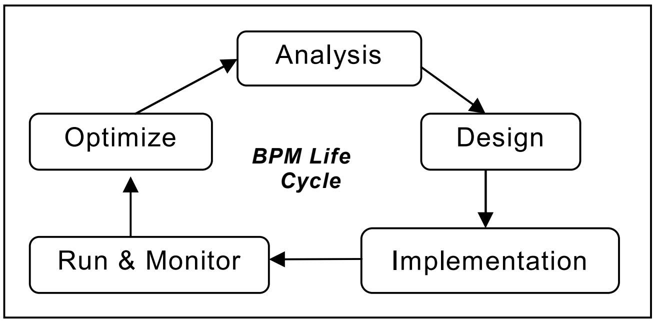


**Fig. 1.4.2: BPM Life Cycle**

(iii) **Implementation phase**: This involves project preparation, blue printing, realization, final preparation, go live and support.

(iv) **Run and Monitor phase**: This involves business process execution or deployment and business process monitoring.

(v) **Optimize**: Iterate for continuous improvement.

## 1.5 Theories of Process Management

At the heart of BPM is the continuous search for ways to progress proficiently. BPM is a combination of systems, methods and tools for ensuring processes that are improved on a continuous basis to achieve enterprise objectives.

Under the BPM framework, **Business Process Re-engineering (BPR)** and incremental process improvement methodologies (i.e., **Six Sigma, TQM**, etc.) are tools that organizations can use to implement process improvement. With a focus on continuous improvement, an organization is better prepared to face change, which is constant in our customer-oriented economy. This helps to develop a corporate culture that is process-oriented; ready to adapt to changes in management at the operational level; and is predominantly about the improvement and control of the processes essential to any business to achieve the objectives of the organization. Setting the direction and goals for business process improvement is a critical step that needs to be addressed by higher management. BPM has evolved with usage of combination of well-known organizational transformation concepts such as BPR, Six Sigma, and TQM; and process-supporting technologies such as workflow management, process analysis and automation suites, and service enabled systems.

### 1.5.1 Six Sigma

Six Sigma is a set of strategies, techniques, and tools for process improvement. It seeks to improve the quality of process outputs by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has quantified value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits. It follows a life-cycle having phases: **Define**, **Measure**, **Analyze**, **Improve** and **Control** (or **DMAIC**) which are described as follows and shown in the Fig. 1.5.1.

(i) **Define**: Customers are identified and their requirements are gathered. Measurements that are critical to customer satisfaction [Critical to Quality, (CTQ)] are identified for further project improvement.

(ii) **Measure**: Process output measures that are attributes of CTQs are determined and variables that affect these output measures are identified. Data on current process are gathered and current baseline performance for process output measures are established. Variances of output measures are graphed and process sigma are calculated.

(iii) **Analyze**: Using statistical methods and graphical displays, possible causes of process output variations are identified. These possible causes are analyzed statistically to determine root cause of variation.

(iv) **Improve**: Solution alternatives are generated to fix the root cause. The most appropriate solution is identified using solution prioritization matrix and validated using pilot testing. Cost and benefit analysis is performed to validate the financial benefit of the solution. Implementation plan is drafted and executed.

(v) **Control**: Process is standardized and documented. Before and after analysis is performed on the new process to validate expected results, monitoring system is implemented to ensure process is performing as designed. Project is evaluated and lessons learned are shared with others.

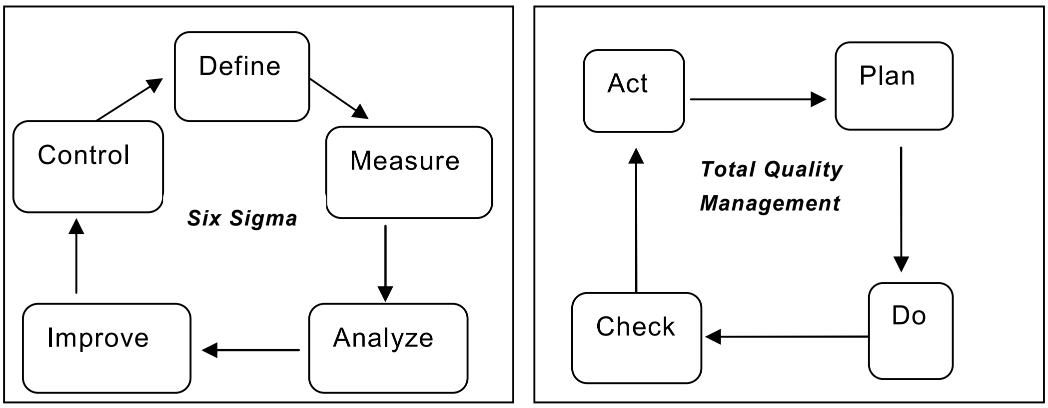


**Fig. 1.5.1: Six Sigma and TQM Cycles**

### 1.5.2 Total Quality Management (TQM)

It is the organization-wide effort to install and make permanent a climate in which it continuously improves its ability to deliver high-quality products and services to customers. Total Quality Management (TQM) is a comprehensive and structured approach to organizational management that seeks to improve the quality of products and services through ongoing refinements in response to continuous feedback. TQM requirements may be defined separately for a particular organization or may be in adherence to established standards, such as the International Organization for Standardization's ISO 9000 series. TQM can be applied to any type of organization; it originated in the manufacturing sector and has since been adapted for use in almost every type of organization imaginable, including schools, highway maintenance, hotel management, and churches. As a current focus of e-business, TQM is based on quality management from the customer's point of view. TQM processes are divided into four sequential categories: **Plan**, **Do**, **Check**, and **Act** (the PDCA cycle) as shown in the Fig. 1.5.1.

(i) **Plan**: In the planning phase, people define the problem to be addressed, collect relevant data, and ascertain the problem's root cause;

(ii) **Do**: In the doing phase, people develop and implement a solution, and decide upon a measurement to gauge its effectiveness;

(iii) **Check**: In the checking phase, people confirm the results through before-and-after data comparison;

(iv) **Act**: In the acting phase, people document their results; inform others about process changes, and make recommendations for the problem to be addressed in the next PDCA cycle.

### 1.5.3 Business Process Reengineering (BPR)

Information Systems are valuable assets that knowledge workers can take advantage of. An important aspect of business process reengineering is combining small granular functions conducted by several persons into functional units of larger granularity, and supporting knowledge workers in performing these tasks with dedicated information systems. Business process management is based on the resources of an enterprise, most prominently on the information systems in place. Information systems enable knowledge workers to perform business process activities in an effective manner. Information systems also have implications on business processes, since some business processes might not be possible without appropriate information system support.

Business Processes need to be re-engineered so as enhance efficiencies or due to change in the processing systems or mechanism. **Business Process Reengineering** is based on the understanding that the products and services a company offers to the market are provided through business processes, and a radical redesign of these processes is the road to success.

The discipline which provides a systematic approach to manage and bring in transformational change is called **Business Process Reengineering (BPR)**. Although, there are many definitions of BPR, the most accepted and formal definition for Business Process Reengineering (BPR) is: ***"*BPR is the fundamental rethinking and radical redesign of processes to achieve dramatic improvement, in critical, contemporary measures of performance such as cost, quality, service and speed"**.

This has a few important key words, which need clear understanding:

- **Dramatic achievement** means to achieve 80% or 90% reduction (in say, delivery time, work in progress or rejection rate) and not just 5%, 10% reduction. This is possible only by making major improvements and breakthroughs, and not small incremental changes like in Total Quality Management (TQM).
- **Radical redesign** means BPR is reinventing and not enhancing or improving. In a nutshell, a "clean slate approach" of BPR says that "Whatever you were doing in the past is all wrong", do not get biased by it or reassemble, the new system is to be redesigned afresh.
- **Fundamental rethinking** means asking the question "why do you do what you do", thereby eliminating business processes altogether if it does not add any value to the customer. There is no point in simplifying or automating a business process which does not add any value to the customer. An example is that of asking for an invoice from the supplier for payment when the company has already received and accepted a particular quantity of materials physically and at an agreed price. Receiving, processing, and filing of invoices add no value to customer and make only the supplier unhappy for delayed payments.

Thus, BPR aims at major transformation of the business processes to achieve dramatic improvement. Here, the business objectives of the enterprise (e.g., profits, customer-satisfaction through optimal cost, quality, deliveries, etc.) are achieved by "transformation" of the business processes which may, or may not, require the use of Information Technology (IT). A radical rethinking on the way the business is run would bring the finest out of the organization. BPR is the main method by which organizations become more efficient and modern. It transforms an organization in ways that directly affect its performance.

## BPR Success factors

BPR implies not just change but dramatic change in the way a business functions. It would potentially impact every aspect of the business and the changes would be of a scale that could result in either drastic improvement or massive failures. Research has identified some key factors for BPR projects to succeed. These factors are as follows:

(i) **Organization wide commitment:** Changes to business processes would have a direct impact on processes, organizational structures, work culture, information flows, infrastructure & technologies and job competencies. This requires strong leadership, support and sponsorship from the top management. Top management not only has to recognize the need for change but also has to convince every affected group about the potential benefits of the change to the organization as a whole and secure their commitment.

(ii) **BPR team composition:** A BPR team is formed which would be responsible to take the BPR project forward and make key decisions and recommendations. The BPR team would include active representatives from top management, business process owners, technical experts and users. It is important that the teams must be kept of manageable size (say 10 members) to ensure well-coordinated, effective and efficient completion of the entire BPR process.

(iii) **Business needs analysis:** It is important to identify exactly what current processes need reengineering. This would help determine the strategy and goals for BPR. A series of sessions are held with the process owners and stakeholders and all the ideas would be evaluated to outline and conceptualize the desired business process. The outcome of this analysis would be BPR project plan – identifying specific problem areas, setting goals and relating them to key business objectives. This alignment of the BPR strategy with the enterprise strategy is one of the most important aspects.

(iv) **Adequate IT infrastructure:** Adequate investment in IT infrastructure in line is of vital importance to successful BPR implementation. An IT infrastructure is a set of hardware, software, networks, facilities, etc. (including all of the information technology), in order to develop, test, deliver, monitor, control or support IT services. Effective alignment of IT infrastructure to BPR strategy would determine the success of BPR efforts.

(v) **Effective change management:** BPR involves changes in people behavior and culture, processes and technologies. Hence, resistance would be a natural consequence which needs to be dealt with effectively. An effective change management process would consider the current culture to foster a change in the prevailing beliefs, attitudes and behaviors effectively. The success of BPR depends on how effectively management conveys the need for change to the people.

(vi) **Ongoing continuous improvement:** BPR is an ongoing process hence innovation and continuous improvement are key to the successful implementation of BPR.

## 1.6 BPM Implementation

BPM is actually paper-based standard operating procedures taken to their most productive level – throughout the initiation of increasingly business-centric technological advances. As the business process may cover different people working in different departments, the organization should also consider allocating issues such as process owners, process managers, and the method of measuring the effectiveness and efficiency of a business process. This also implies that, with most organizations, the business and IT should be involved. In the end, the organization should develop a mindset that implementing BPM technology can contribute towards an organization becoming process-centric.

People are at the center of business processes and hence it is imperative to make them part of the solution. The key to a successful BPM implementation is to consider it not just as an improvement programs but make it an integral part of business strategy. An effective BPM implementation has to result in the institutionalization of process improvement as a fundamental management practice. This can be effectively achieved through proactive and predictive management of relevant business processes. BPM requires enterprise to align its' processes with enterprise goals, find ways to improve those processes and then establish measurements that can be used to track and monitor performance for continuous improvement and optimization. Processes are multi-functional and need to be properly integrated. Effective streamlining of process requires process management to be implemented. Process management is a functional group including (but not limited to) operations management, Supply Chain Management, Finance and Accounting, Marketing, and General Management. Process management provides a sequence of analytical tools that are essential to the modern project manager, analyst, and management consultant.

The payback of BPM implementation is enormous in any economic surroundings. But achieving business quickness in a turbulent, competitive global market is all the easier with BPM tools. Spread across industry sectors, these companies stand out for their quick come back to revolutionize, proficient cost structures, enhanced revenue models and optimal growth levels. By providing an adjustable structure to make key corporate decisions, BPM helps organizations optimize both work and revenues.

### 1.6.1 Key factors to consider in implementing BPM

Table 1.6.1 illustrates the key factors to be considered in implementing BPM.

**Table 1.6.1: Key factors and related considerations in implementing BPM**

| Factors | Key Considerations |
|---|---|
| **Scope** | A single process, a department, the entire company |
| **Goals** | Process understanding, improvement, automation, re-engineering, optimization |
| **Methods to be used** | Six Sigma, BPM Life Cycle Method, TQM, Informal methods |
| **Skills Required** | Consultants, Train Employees, Formal Certification, Basic Education, Existing Skill sets |
| **Tools to be used** | White-Boards, Sticky Notes, Software For Mapping, Documenting, Software for Simulation, Comprehensive BPMS |
| **Investments to Make** | Training, Tools, Time |
| **Sponsorship/Buy-in Needed** | Executive Level, Department Level, Process Owner Level, Employee Level |

### 1.6.2 Need for a BPM implementation

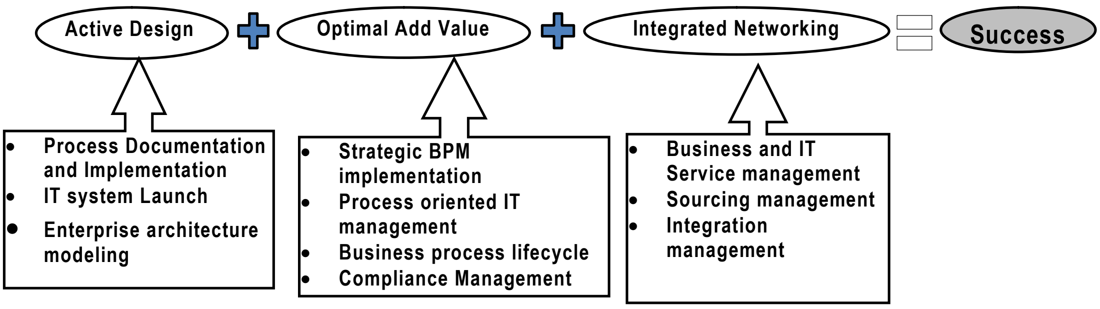


**Fig. 1.6.1: BPM leads to success**

Thus BPM will be the mechanism to:

- Create the long-term future positioning of the business and enhance its future capability;
- Create short-term cost effectiveness and improvement to current customer service;
- Initiate continuous improvement from the base of the current, but improved, processes;
- Introduce a knowledge of product and customer profitability;
- Re-engineer the business radically and provide clear future competitive differentiation;
- Address the cultural barriers that prevent effective cross-functional and hierarchical working;
- Introduce leadership and a role for managers and empowered staff.

Business processes are all around us, independent of the market, organization, department or function – whether a telecom operator providing an internet connection, a bank processing a loan application, an insurance company handling a claim, or a local government organization processing a request for a new passport. Any organization is the sum of its business processes and is the fundamental part of any organization's infrastructure as depicted in the Fig. 1.6.1. In all the above examples, the volume of work and the complexity of the business process demand that organizations look for possible IT applications to support and automate their processes.

Throughout the years, many companies have invested millions in all sorts of IT solutions. The marketing department has its Enterprise Content Management (ECM) system, used to inform the consumer of the organization's products or services. The sales department has a Customer Relation Management (CRM) system to allow the company to up- and cross-sell, and finally the delivery department has an Enterprise Resource Planning (ERP) system to process the order and send an invoice. The challenge for today's organizations is that these departments operate as independent functional units.

### 1.6.3 Automation of the functional units

The consumer is often confronted with poor customer service due to broken processes, inefficient processes and manual processes – that is, the customer is often confronted with the silos of the organization.

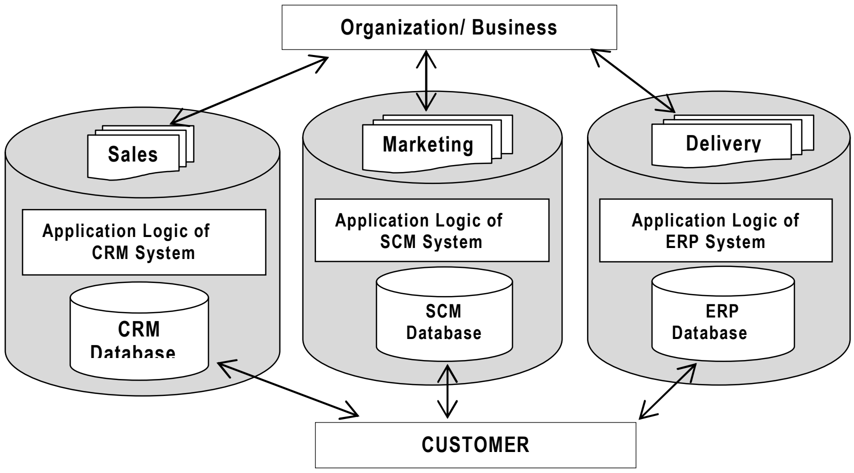


**Fig. 1.6.2: Automation of the functional units**

However, the same consumer is becoming more and more demanding with respect to delivery time – where customers used to expect and accept days or weeks for delivery, same time, the consumer is demanding higher quality of the products or services. Finally, the product or service is becoming more and more personalized (and thus more complex), supported by increased customer services. Refer to the Fig. 1.6.2.

### 1.6.4 Business Process Automation (BPA): Benefits & Risks

Business Process Automation (BPA) is a strategy that is used to optimize and streamline the essential business processes, using the latest technology to automate the functions involved in carrying them out. BPA allows the organizations to extract maximum benefit by using the available resources to their best advantage, while keeping the operational cost as low as possible. Doing so helps the enterprise to generate greater profits and achieve a level of stability that would be hard to realize without the use of automation.

The core objective of BPA is achieved through integrating various business processes. The key benefits and risks of BPA are given below:

**Benefits**

- **Saving on costs:** Automation leads to saving in time and labor costs.
- **Staying ahead in competition:** Today, in order to survive, businesses need to adopt automation.
- **Fast service to customers**: This was not the initial reason for adoption of BPA but gradually business managers realized that automation could help them to serve their customers faster and better.

**Risks**

- **Risk to jobs:** Jobs that were earlier performed manually by several employees would post-automation would be mechanized, thereby posing a threat to jobs.
- **False sense of security:** Automating poor processes will not gain better business practices.

### 1.6.5 Challenges in implementing BPA

How can any organization adjust with these increased demands in an environment where, at the same time:

- The number of interfaces with the customers is growing (e.g. phone, fax, email, sms, PDA, etc.)
- The product, service and price options have increased the complexity of the business
- Most organizations have a whole suite of 'build and buy' systems and applications, often each with its own data format
- Budgets are being cut.

Organizations are realizing that all the organization's assets, systems, departments and people are interlinked. Referring to the Fig. 1.6.3, there are numerous internal processes that form an internal supply chain, which relate to the end-to-end process of the organization. Basically, one simple interface with the organization would be preferable:

- **Marketing** – what product or service do you have to offer?
- **Sales** – please treat me as one single client
- **Delivery** – please provide the product or service as quickly as possible.

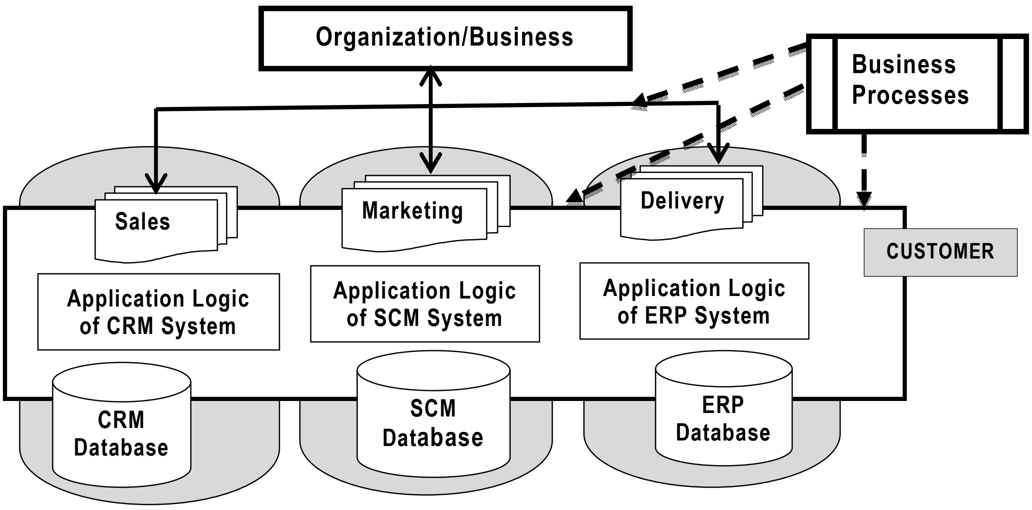


**Fig. 1.6.3: Enterprise Business Systems: end-to-end customer processes.**

Realizing that an organization could be seen as a sum of its business processes is the key element in selling a BPM and automation is not just about implementing technology, it is also about automating the business processes in the right circumstances. Existing applications can be linked to each other by an independent process layer. BPM automation is also about a new way of working, monitoring and managing the organization, which could result in a new organizational structure.

*For further details on BPA, students may refer to Chapter – 5 "Business Process Automation Through Application Software" of the Study Material of Intermediate (IPC) Course.*

### 1.6.6 BPM Technology

BPM technology can complement existing (and future) investments in applications and give organizations the ability to implement a real – time process improvement without the extensive process conversion efforts as the original business processes already exist. To achieve these benefits, Business Process Layer is introduced in the Traditional IT architecture. The traditional IT architecture contains three layers: Database, Application and Presentation. The Database layer physically contains data; Application Layer contains applications and process logic; and Presentation Layer is what users see. In Four-layered architecture, the Process Layer is situated between Presentation and Application Layer as shown in the Fig. 1.6.4.

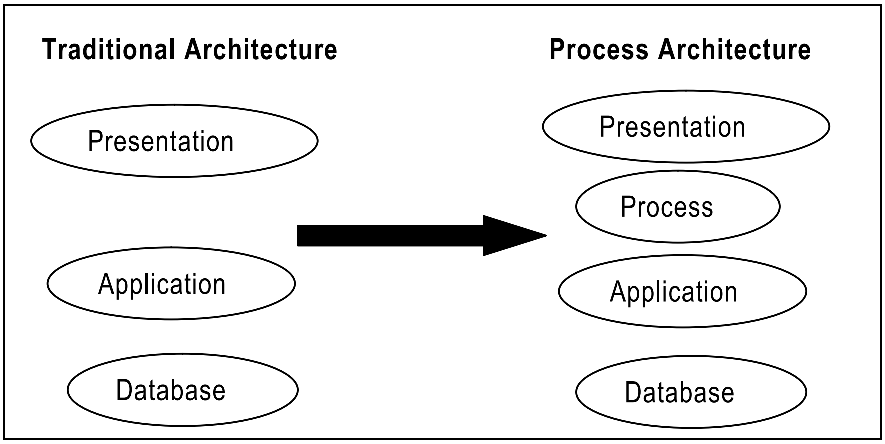


**Fig. 1.6.4: Traditional Architecture versus Process Architecture***

BPM provides an independent process layer, linking the various independent applications needed to execute a single end-to-end business process. BPM technology can then manage the flow of activities along different applications, and the people involved and also reduce execution time. By tracking the business process, an organization can monitor its performance and at the same time audit for compliance. Analyzing information helps to improve the business processes further. All this can increasingly be completed in real time; management

* "Business Process Management Systems, Strategy and Implementation", James. F Chang, Auerbach Publications, Page No. 56

can make instant changes and validate if the changes are having the desired effect. Experience shows that organizations which are successful in exploiting BPM technology start by solving a specific business problem with a clear, short-term Return On Investment (ROI). Thus, anybody selling BPM, both internal and external to an organization, should consider both parts of the equation:

**BPM = Process and Organization (including people) as well as Technology**

### 1.6.7 Value Chain Automation

**Value chain** refers to separate activities which are necessary to strengthen an organization's strategies and are linked together both inside and outside the organization. It is defined as a chain of activities that a firm operating in a specific industry performs in order to deliver a valuable product or service for the market.

The idea of the Value Chain is based on the process view of organizations, the idea of seeing a manufacturing (or service) organization as a system, made up of subsystems each with inputs, transformation processes and outputs. Value chain of a manufacturing organization comprises of Primary and Supportive activities. The primary ones are inclusive of inbound logistics, operations, outbound logistics, marketing and sales, and services. The supportive activities relate to procurement, human resource management, technology development and infrastructure. Six business functions of the value chain are as follows:

- Research and development
- Design of products, services, or processes
- Production
- Marketing and sales
- Distribution
- Customer service

Value Chain Analysis is a useful tool for working out how we can create the greatest possible value for our customers. IT helps us identify the ways in which we create value for our customers and then helps us think through how we can maximize this value: whether through superb products, great services, or jobs well done.

## 1.7 Accounting Systems Automation

An **Accounting Information System** which is known as **AIS** is defined as a system of collection, storage and processing of financial and accounting data that is used by decision makers. An Accounting Information System is generally a computer-based method for tracking accounting activity in conjunction with information technology resources. The resulting statistical reports can be used internally by management or externally by other interested parties including investors, creditors and tax authorities.

### 1.7.1 Basic Functions of an Accounting Information System (AIS)

Accountants and Auditors must study and understand AIS and related concepts so that they can accomplish the functions of accounting, general accounting reports and using accounting reports. The Accounting Information System is the mechanism that allows accountants to perform their accounting functions and tasks. Further, in automation of AIS, accountants and auditors need to be actively involved in evaluating which software to purchase, how to design the software or systems and implementation of the software or systems. As auditors in auditing AIS, understanding of AIS is critical for collecting and evaluating evidence to provide an opinion/report on the completeness and accuracy of accounting information which is processed through AIS to produce the financial reports. There are three basic functions of AIS and these are explained here.

(i) **Collect and store data:** Collect and store data about organization's business activities and transactions by capturing transaction data from source documents and posting data from journals to ledgers. Source documents are special forms used to capture transaction data such as sales order, sales invoice, order processing, purchase order, etc. Control over data collection is improved by pre-numbering each source document. Accuracy and efficiency in recording transaction data can be further improved if source documents are properly designed. The Fig. 1.7.1 shows the system input documents through a system process flow namely source documents, product documents and turnaround documents.

(ii) **Record transaction:** Record transactions data into journals. These journals present a chronological record of what occurred and provide management with information useful for decision making. These documents are in the form of reports like financial statements, managerial reports, etc.

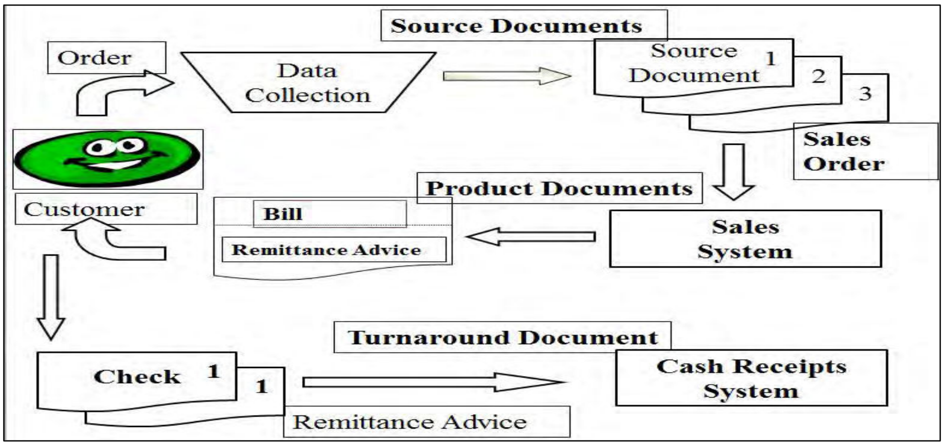


**Fig. 1.7.1: System input documents for accounts BPM**

(iii) **Safeguard organisational assets:** Provide adequate controls to ensure that data are recorded and processed accurately by safeguarding organizational assets (data and systems). The two important methods for accomplishing this objective are by providing adequate documentation of all business activities and an effective segregation of duties. Documentation allows management to verify that assigned responsibilities were completed correctly. Segregation of duties refers to dividing responsibility for different portions of a transaction among several people. The functions to be performed by different people are authorizing (approval) transactions, recording (capture) transactions and maintaining custody (protect) of assets, thereby ensuring that business activities are performed efficiently and in accordance with management's objectives.

### 1.7.2 Processing Cycles of an Accounts BPM

**A. Processing Cycles of Accounts BPM:** These are namely **Financing Cycle, Revenue Cycle, Expenditure Cycle, Human Resource Cycle,** and **Production Cycle** and are identified in the Fig. 1.7.2.

(i) **Financing Cycles:** A transaction processing cycle combines one or more types of transactions having related features or similar objectives. The cycle consists of a set of transactions leading to the recognition of a major economic event on the financial statements. It is through the study of transaction cycles that we gain a clear view of a firm's processing framework.

(ii) **Revenue Cycle:** It includes transactions surrounding the recognition of revenue involving accounts like Sales, Accounts Receivable, Inventory and General Ledger. It involves capturing and recording of customer orders; shipment of the goods; and recording of the cost of goods sold; the billing process and the recording of sales and accounts receivable; and the capturing and recording of cash receipts.

| Source Document | Function |
|---|---|
| Sales Order | Record Customer Order |
| Delivery Ticket | Record Delivery to Customer |
| Remittance Advice | Receive Cash |
| Deposit Slip | Record Amounts Deposited |
| Credit Memo | Support Adjustments to Customer Accounts |

**Revenue Cycle : Common Source Documents & Functions**

(iii) **Expenditure Cycle:** It includes transactions surrounding the recognition of expenditures involving accounts like Purchases, Accounts Payable, Cash Disbursements, Inventory and General Ledger. It includes preparation and recording of purchase orders; receipt of goods and the recording of the cost of inventory; receipt of vendor invoices; recording of accounts payable and preparation and recording of cash disbursements. The cycle also includes the preparation of employee paychecks and the recording of payroll activities.

| Source Document | Function |
|---|---|
| Purchase Requisition | Request that purchasing department order goods. |
| Purchase Order | Request goods from vendors. |
| Receiving Report | Record receipt of merchandise. |
| Check | Pay for items. |

**Expénditure Cycle : Common Source Documents & Functions**

(iv) **Human Resource Cycle:** This involves activities of hiring and paying employees.

| Source Document | Function |
|---|---|
| W4 forms | Collect employee withholding data. |
| Time cards | Record time worked by employees. |
| Job time tickets | Record time spent on specific jobs. |

**Human Resource Cycle: Common Source Documents & Functions**

(v) **Production Cycle:** This involves the recurring set of business activities and related data processing operations associated with the manufacturer of products including activities like converting raw materials and labor into finished goods.

**B. General Ledger & Reporting System:** The information processing operations involved in updating the general ledger and preparing reports, summarize the results of an organization's activities. An important function of the AIS is to efficiently and effectively collect and process the data about a company's transactions.

| General Ledger and Reporting System | |
|---|---|
| Journal Voucher | Record entry posted to general ledger. |

**General Ledger & Reporting System - Common Source Documents & Functions**

**C. Data Processing Cycle:** It may be noted, that all the above cycles of processing involves data processing activities which has been updated and stored. The stored information has details about the resources affected by the event and agents who participated in the activity. If the process of updating of the data stored is periodic, it is referred to as batch processing and if involves immediate updating as each transaction occurs, it is referred to as on-line, real-time processing. In the data processing cycle, the processes of business activities about which data must be collected and processed are identified. Further, the activities, resources affected by that event, the agents who participate in that event and the event of interest could be the input, output, processing, storage, alerts, controls and feedback.

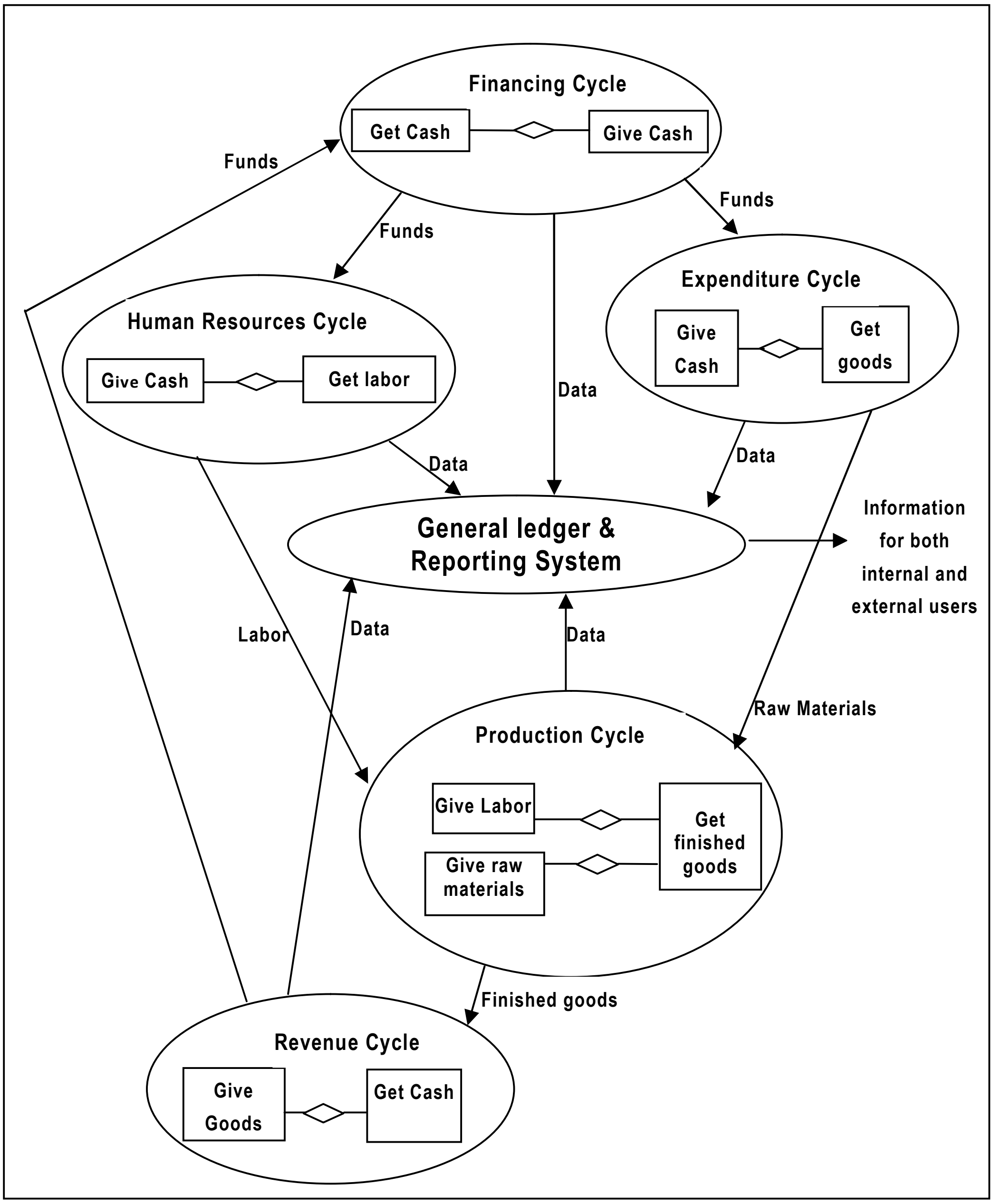


**Fig. 1.7.2: Accounting Information Systems and its Subsystems**

The Data Processing Cycle consists of following basic steps with alerts, controls and feedback at each step:

- **Data input -** Involves the activities like capturing the data, implementing control procedures, recording in journals, posting to ledgers and preparation of reports.

- **Data storage** - Involves organizing the data in master file or reference file of an automated system for easy and efficient access.
- **Data processing** - Involves addition, deletion and updating of the data in the transaction file, master file or reference file.
- **Information output** - Involves generation of documents and managerial reports in printable or electronic form for addressing queries, to control operational activities and help the management in decision making.

The controls on the data are maintained using Audit Trials. This is done by capturing snapshots or by tracing the flow of data. This provides a means to check the accuracy and validity of ledger postings. Storage of these data is in files named General Ledger, Accounts Payable ledger and Accounts Receivable ledger.

## 1.8 Impact of IT on BPM and Risks of failure of IT

BPM Systems or suites (BPMS) are a new class of software that allows enterprises to devise process centric IT solutions. 'Process-centric' means BPM solutions are able to integrate people, systems and data (see Fig. 1.8.1 given below).

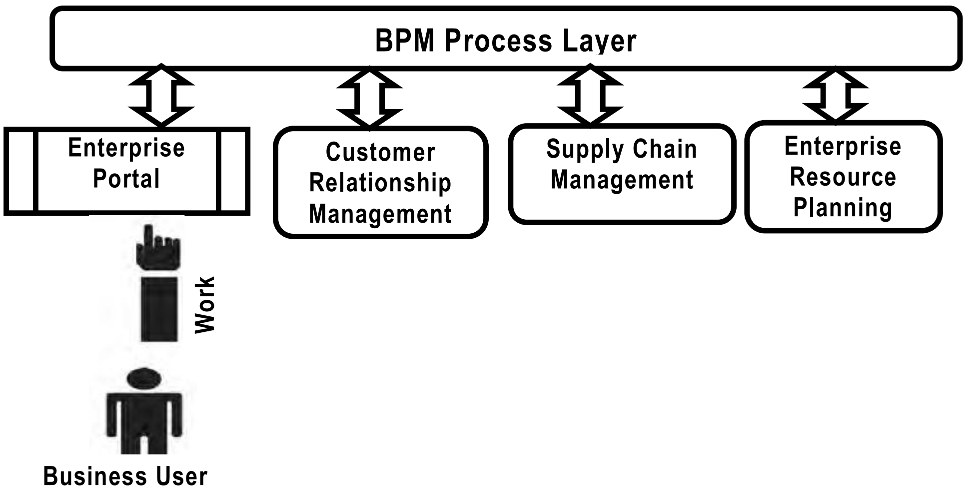


**Fig. 1.8.1: Integration of People and Systems by BPM***

Organizations that utilize BPM systems to accomplish IT enabled business process change, gain from the following capabilities:

- Closer business involvement in designing IT enabled business processes,
- Ability to integrate people and systems that participate in business processes,

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* "Business Process Management Systems, Strategy and Implementation", James. F Chang, Auerbach Publications, Page No. 52

- Ability to simulate business processes to design the most optimal processes for implementation,
- Ability to monitor, control, and improve business processes in real time, and
- Ability to effect change on existing business processes in real time without an elaborate process conversion effort.

### 1.8.1 Benefits of BPMS

BPMS, as a technology, can deliver endless benefits to any sized organization but more importantly these benefits are unique to a company:

**(a) Automating repetitive business processes:** Processes such as report creation and distribution or the monitoring of or reporting on company's Key Performance Indicators (KPI) reduces the manual operational costs and helps employees to concentrate on activities that are important to the success of business.

**(b) BPMS works by 'loosely coupling' with a company's existing applications:** This enables it to monitor, extract, format and distribute information to systems and people; in line with business events or rules.

**(c) Operational Savings:** BPM focuses on optimization of processes. The processes that are repetitive are optimized and lead to reduced expenses which translate to immediate cost savings. By automating a task, ROI of BPM that requires six hours of manual intervention, one can expect to cut that time to half. Thus, three hours multiplied by the number of times the process is completed in a cycle will yield significant cost saving.

**(d) Reduction in the administration involved in Compliance and ISO Activities:** Be it a quality assurance initiative such as the ISO standards, a financial audit law, or an IT systems best-practice implementation, companies worldwide are seeing the need to manage compliance as part of their everyday business activities. The BPM is ideally suited to help support companies in their quest for process improvement and compliance/governance certification. It gives full control over process and document change, clarity of inherent risks, and ease with which process knowledge is communicated across the company.

**(e) Freeing-up of employee time:** While the euphuism "time is money" is often over-used, it is very relevant to this topic, because in business, for each additional hour it takes to complete a manual business process, there is a hard cost associated with employee time as well as soft costs associated with losing business or lowered productivity. Another area where time comes into play is in opportunity costs.

BPM or BPR software is a fast-growing segment of the enterprise software market, due to its support for re-engineering. Using BPM software tools, enterprises can document workflow and processes, to identify bottlenecks and other impediments to effectiveness, and recommend alternative and improved business processes. The purpose of BPM software is to update the documentation, analysis, monitor and re-design business processes in an enterprise.

### 1.8.2 Business Risks of failure of IT

The numerous stumbling-blocks that organizations face with BPMS are primarily due to inadequate investment in ongoing training for involved personnel, as well as, lack of corporate policy protecting the integrity of the data in the BPM systems. Some of the other reasons for failure of BPMS include the following:

- Superficial or deficient executive involvement
- Deficient project management
- Breakdown in gap analysis
- Limited options for customization of the BPM software is required
- Not flexible enough or too complicated to be customized to meet the precise workflow and business process.
- Failure to identify future business needs
- Inadequate assessment of the need for change management
- Persistent compatibility problems with the diverse legacy systems of the partners.
- Resources not available when desirable
- Software fails to meet business needs
- System may be over-engineered when compared to the actual requirements.
- Technological obsolescence.

### 1.8.3 Information as a Business Asset

For information to be used effectively - and therefore to maximize its strategic value - it must be available as a shared, easily accessible service within an organization by continuous updating the old database system. Information becomes an asset for an organization if it is useful, digital, accessible, relevant, accurate, trust-worthy, searchable, understandable, spatially enabled and shareable at the time when required. Information can be treated as a valuable commodity if it can be used effectively.

Information that is accurate and encompassing will allow decision-makers to better an organization's performance. Without reliable information, the decision-making process can be badly hampered and an informed decision impossible to make. Where a business is geographically dispersed, with servers hosted in different locations, or a business has a network of applications, there can also be the obstacle of replicating data across the network.

In short, without effectively management of information the result can be information chaos.

To achieve operational performance, it is important to ensure that Information Technology infrastructure is tailored to an organization that is able to meet an organization's needs for

Customer Relationship Management (CRM), Enterprise Resource Planning (ERP), Business Intelligence (BI), Data Warehousing, Data Migration and Replication.

## 1.9 Approaches to Mapping Systems

Accountants do not need to have the ability to program complex systems, but is it important for them to understand the documentation that describes how processing takes place. Documentation includes the flowcharts, narratives and other written communications that describe the inputs, processing and outputs of an Accounting Information System. Documentation also describes the logical flow of data within a computer system and the procedures that employees must follow to accomplish application tasks.

Some of the reasons why documentation is important to Information Systems are as follows:

(a) **Depicting how the system works**: In computerized systems, the processing is electronic and invisible. Therefore documentation is required to help employees understand how a system works, assist accountants in designing controls for it, demonstrates to managers that it will meet their information needs, and assists auditors in understanding the systems that they test and evaluate.

(b) **Training users**: Documentation also includes user guides, manuals, and similar operating instructions that help people learn how an Information System operates. These documentation aids help train users to operate Information systems hardware and software, solve operational problems, and perform their jobs better.

(c) **Designing new systems**: Documentation helps system designers develop new systems in much the same way that blueprints help architects design building, Well-written documentation and related graphical systems-design methodologies play key roles in reducing system failures and decreasing the time spent correcting emergency errors.

(d) **Controlling system development and maintenance costs**: Personal computer applications typically employ prewritten, off-the-shelf software that is relatively reliable and inexpensive. Good documentation helps system designers develop object-oriented software, which is software that contains modular, reusable code that further avoid writing duplicate programs and facilitate changes when programs must be modified later.

(e) **Standardizing communications with others**: Documentation aids such as E-R Diagrams, System Flowcharts, and Data Flow Diagrams are more standardized tools, and they are more likely to be interpreted the same way by all parties viewing them. Thus, documentation tools are important because they help describe an existing or proposed system in a common language and help users communicate with one another about these systems.

(f) **Auditing Information Systems**: Documentation helps depict audit trails, For example- when investigation and Accounting Information system, the auditors typically focus on internal controls. In such circumstances, documentation helps auditors determine the strengths and weaknesses of a system's controls and therefore the scope and complexity of the audit.

(g) **Documenting business processes**: Understanding business processes can lead to better systems and better decision. Documentation helps managers better understand how their businesses operate what controls are involved or missing from critical organizational activities, and how to improve core business activities.

Insufficient and deficient documentation costs organizations time and money and good documentation can be as important as the software it describes. Some of the popular pictorial representation or techniques which may be adopted for mapping business processes used are explained below. These are as follows:

1. Entity Relationship Diagram;
2. Data Flow Diagram;
3. Flowchart;
4. Decision Tree; and
5. Decision Table

## 1.9.1 Entity Relationship Diagram

An **Entity-Relationship (ER) diagram** is a data modeling technique that creates a graphical representation of the entities, and the relationships between entities, within an information system. ER diagrams repeatedly bring into play symbols to symbolize three dissimilar types of information.

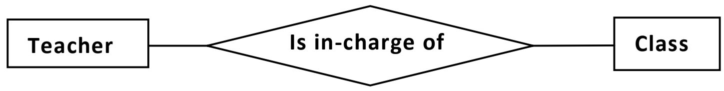
- **Boxes** are commonly used to represent **entities.** An entity may be a 'physical object' such as a house or a car, an 'event' such as a house sale or a car service, or a 'concept' such as a customer transaction or order. The entity is represented by a rectangle and labeled with a singular noun.
- **Diamonds** are normally used to represent **relationships**. A relationship is an association that exists between two entities. For example, Instructor teaches Class or Student attends Class. Most relationships can also be stated inversely. For example, Class is taught by Instructor. The relationships on an ER Diagram are represented by lines drawn between the entities involved in the association.
- **Ovals** are used to represent **attributes**.

### Types of Relationships

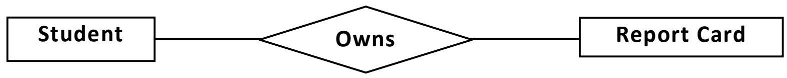
The various types of relationships have been shown in the Fig.1.9.1.

**(i) One-to-One relationship (1:1) -** A One-to-One relationship is shown on the diagram by a line connecting the two entities.

**Example:** A Teacher may be in-charge of a class. Each class must be in-charge of by one teacher.

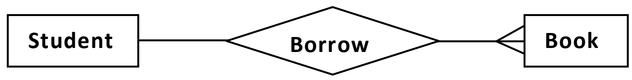



A student has one and only one Report card. Each report card is owned by one and only one student.

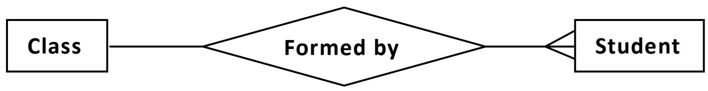



**(ii) One-to-Many relationship (1:N) –** A One-to-Many relationship is shown on the diagram by a line connecting the two entities with a "crow's foot" symbol denoting the 'many' end of the relationship.

**Example:** A student may borrow some books from the library. A book in the library may be borrowed by at most a student.




A class is formed by a group of atleast one student. Each student is allocated to one and only one class.




Further, a teacher teaches many courses.

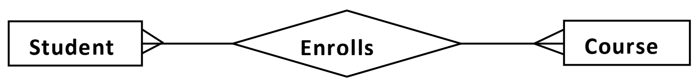
**(iii) Many-to-One relationship (M:1) –** It is the reverse of One-to-Many relationship.

**Example:** As in two or more parent records to a single child record. For example,

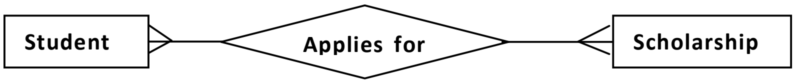

When three administrators in a small town report to one minister.


**(iv) Many-to-Many relationships (M:N) -** A Many-to-Many relationship is shown on the diagram by a line connecting the two entities with 'crow's foot' symbols at both ends.

**Example:** A student enrolls in atleast one course. A course is enrolled by at least one student.



A student may apply for more than one scholarship. Each scholarship may receive some applications from student, or none.




**Advantages of using E-R Diagram**

- ER Modeling is simple and easily understandable. It is represented in business users' language and it can be understood by non-technical specialist.
- Intuitive and helps in Physical Database creation.
- Can be generalized and specialized based on needs.
- Can help in database design.
- Gives a higher level description of the system.

**Limitations of using E-R Diagram**

- Physical design derived from E-R Model may have some amount of ambiguities or inconsistency.
- Sometime diagrams may lead to misinterpretations.

**Example 1:** Construct an E-R diagram for a car-insurance company whose customers own one or more cars each. Each car has associated with it zero to any number of recorded accidents.

**Solution:** Fig. 1.9.1 shows an example for Car Insurance Company. The underline represents the key elements.

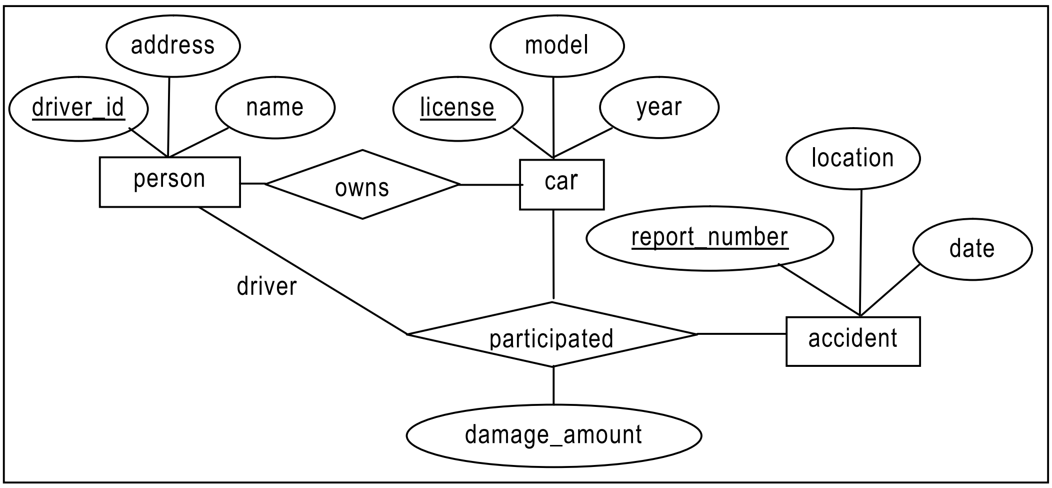



**Fig. 1.9.1: E-R Diagram for Car Insurance Company**

### 1.9.2 Data Flow Diagram

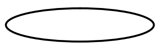
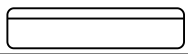
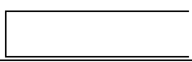
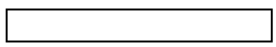
**Data Flow Diagram (DFD)** is a graphical representation of the flow of data through an information system. A DFD illustrates technical or business processes with the help of the external data stored, the data flowing from a process to another, and the results. DFDs may be partitioned into levels that represent increasing information flow and functional detail. Therefore, the DFD provides a mechanism for functional modeling as well as information flow modeling.

The four major DFD component's symbols are explained in the Table 1.9.1:

(i) **Entity:** An entity is the source or destination of data. The source in a DFD represents these entities that are outside the context of the system. Entities either provide data to the system (referred to as a source) or receive data from it (referred to as a sink). Entities are often represented as rectangles (a diagonal line across the right-hand corner means that this entity is represented somewhere else in the DFD). Entities are also referred to as agents, terminators, or source/sink.

(ii) **Process:** The process is the manipulation or work that transforms data, performing computations, making decisions (logic flow), or directing data flows based on business rules. In other words, a process receives input and generates some output. Process names (simple verbs and dataflow names, such as "Submit Payment" or "Get Invoice") usually describe the transformation, which can be performed by people or machines. Processes can be drawn as circles or a segmented rectangle on a DFD, and include a process name and process number.

**Table 1.9.1: Symbols used in DFD**

| Meaning | Symbols |
|---|---|
| **Process** |  **or**  |
| **Data Store** |  **or**  |
| **Entity** |  |
| **Data Flow** | ⟶ |

(iii) **Data Store:** A data store is where a process stores data between processes for later retrieval by that same process or another one. Files and tables are considered data stores. Data store names (plural) are simple but meaningful, such as "customers", "orders" and "products." Data stores are usually drawn as a rectangle with the right hand side missing and labeled by the name of the data storage area it represents, though different notations do exist.

(iv) **Data Flow:** Data flow is the movement of data between the entity, the process and the data store. Data flow portrays the interface between the components of the DFD. The flow of data in a DFD is named to reflect the nature of the data used (these names should also be unique within a specific DFD). Data flow is represented by an arrow, where the arrow is annotated with the data name.

Any system in general is too complex to be shown on a single DFD. Decomposition is an iterative process of exploding DFDs to create more detail. Data Flow Diagrams can be expressed as a series of levels. We begin by making a list of business activities to determine the DFD elements (external entities, data flows, processes, and data stores). Context Diagram shows the interaction between the system and external agents.

The Context Diagram is a high-level DFD that shows the entire system as a single process and shows the interaction between the system and external agents which act as data sources and data sinks, and gives no clues as to its internal organization. The context-level DFD is next "exploded", to produce Level 1 DFDs for each process that show how the system is divided into sub-systems (processes), each of which deals with one or more of the data flows to or from an external agent, and which together provide all of the functionality of the system as a whole. There are two types of DFDs:

| | |
|---|---|
| **Logical Data Flow Diagram** | A logical DFD focuses on the business and how the business operates. It describes the business events that take place and the data required and produced by each event. The logical model reflects the business. |
| **Physical Data Flow Diagram** | A physical DFD shows how the system will be implemented. The physical model depicts the system. |

**Advantages of using Data Flow Diagram**

- It aids in describing the boundaries of the system.
- It is beneficial for communicating existing system knowledge to the users.
- A straightforward graphical technique which is easy to recognize.
- DFDs can provide a detailed representation of system components.
- It is used as the part of system documentation file.
- DFDs are easier to understand by technical and nontechnical audiences
- It supports the logic behind the data flow within the system.

**Limitations of using Data Flow Diagram**

- It make the programmers little confusing concerning the system.
- The biggest drawback of the DFD is that it simply takes a long time to create, so long that the analyst may not receive support from management to complete it.
- Physical considerations are left out.

**Example 2:** Draw a Context Diagram for a Bank System that interacts with the following five agents: Customers, Bank Managers, Third Parties, Sales agents and Other Banks.

**Solution:** The Context Diagram is shown in the Fig. 1.9.2. This diagram shows the entirety of our proposed **Bank System** encapsulated as a single process that sends data to and receives data from various external interfaces.

The interfaces to the right represent human actors.

(a) **Customers** can send **Deposit and Withdrawal requests** to our system and can receive **statements** from it.

(b) **Bank Managers** can send **Open and Close Account Requests** to the system and can receive **Management reports** from it.

(c) **Third Parties** can send **third party deposits** to the system, but obviously not make withdrawal requests.

The interfaces to the right represent system actors.

(d) The first interface on the left represents the **Other Banks** which may send or receive **Money Transfers** when interacting with our system. These other banks are likely to be system actors (i.e. computer programs) rather than human actors.

(e) The second interface on the left represents the **Sales Agents**, which are external affiliate companies or individuals who generate **Customer Introductions** for our system.

While the Context Diagram shows the kind of data that is exchanged between the system and the external interfaces, it implies nothing at all regarding the sequence in which those data exchanges take place.

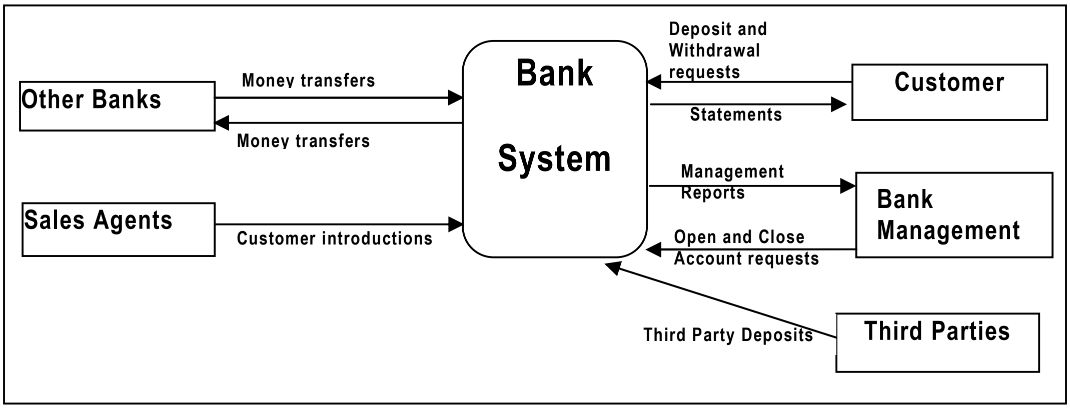



**Fig. 1.9.2: Context Diagram of a Bank System**

### 1.9.3 Flowchart

A **Flowchart** is a type of diagram that represents an algorithm, workflow or process, showing the steps as boxes of various kinds, and their order by connecting them with arrows. Flowcharts are used in analyzing, designing, documenting or managing process or program in various fields. It is like a blueprint, in that it shows the general plan, architecture, and essential details of the proposed structure. It is an essential tool for programming and it illustrates the strategy and thread of logic followed in the program. It allows the programmer to compare different approaches and alternatives on paper and often shows interrelationships that are not immediately apparent. A flowchart helps the programmer avoid fuzzy thinking and accidental omissions of intermediate steps. Fig. 1.9.3 details all the flowcharting symbols:

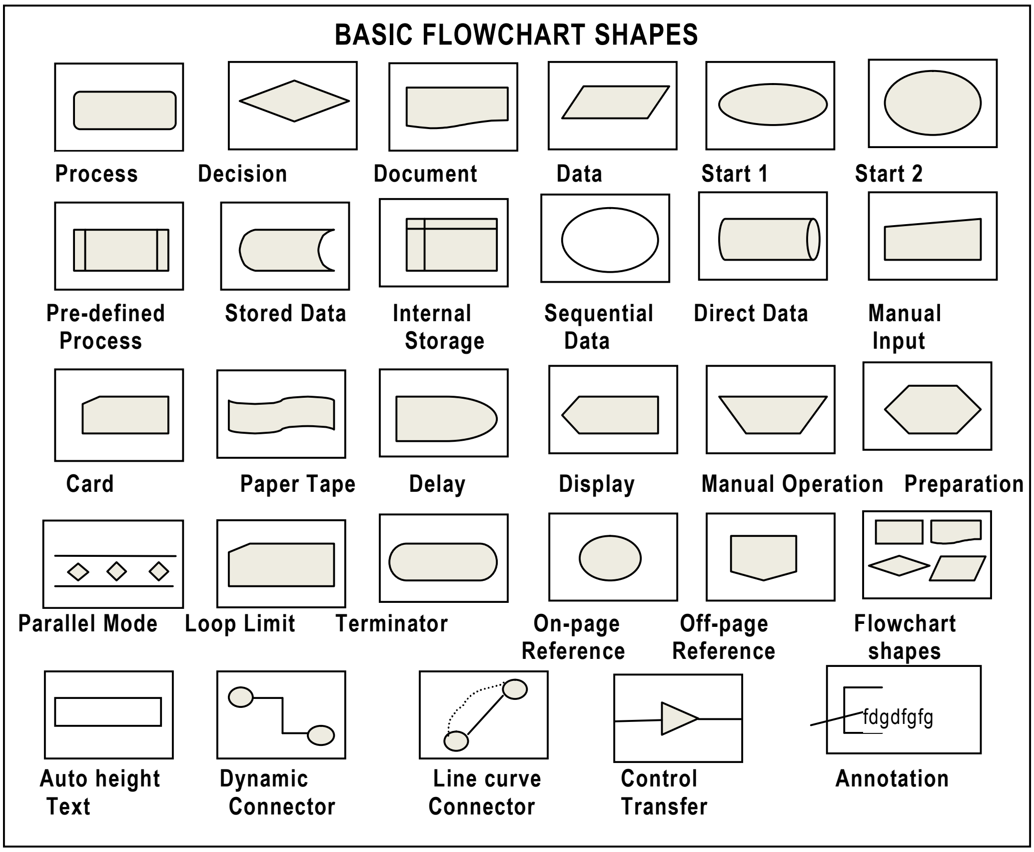



**Fig. 1.9.3: Standard Flowchart Symbols**

However, many classification of Flowchart exists; broadly, they are categorized as below in Table 1.9.2:

**Table 1.9.2: Flowchart Types**

| Type of Flowchart | Explanation |
|---|---|
| **Document Flowchart** | This flowchart traces the physical flow of documents through an organization – that is, the flow of documents from the departments, groups, or individuals who first created them to their final destinations. |
| **System Flowchart** | This typically depicts the electronic flow of data and processing steps in an Information System. While Document Flowcharts focus on tangible documents, system flowchart concentrates on the computerized data flows of Information systems. |
| **Program Flowchart** | It is most detailed and is concerned with the logical/arithmetic operations on data within the CPU and the flow of data between the CPU on the one hand and the input/output peripherals on the other. |

## Advantages of using Flowchart

(i) **Quicker grasp of relationships –** Before any application can be solved, it must be understood, the relationship between various elements of the application must be identified. The programmer can chart a lengthy procedure more easily with the help of a flowchart than by describing it by means of written notes.

(ii) **Effective Analysis –** The flowchart becomes a blue print of a system that can be broken down into detailed parts for study. Problems may be identified and new approaches may be suggested by flowcharts.

(iii) **Communication** – Flowcharts aid in communicating the facts of a business problem to those whose skills are needed for arriving at the solution.

(iv) **Documentation –** Flowcharts serve as a good documentation which aid greatly in future program conversions. In the event of staff changes, they serve as training function by helping new employees in understanding the existing programs.

(v) **Efficient coding** – Flowcharts act as a guide during the system analysis and program preparation phase. Instructions coded in a programming language may be checked against the flowchart to ensure that no steps are omitted.

(vi) **Orderly check out of problem** – Flowcharts serve as an important tool during program debugging. They help in detecting, locating and removing mistakes.

(vii) **Efficient program maintenance –** The maintenance of operating programs is facilitated by flowcharts. The charts help the programmer to concentrate attention on that part of the information flow which is to be modified.

### Limitations of using Flowchart

(i) **Complex logic** – Flowchart becomes complex and clumsy where the problem logic is complex. The essentials of what is done can easily be lost in the technical details of how it is done.

(ii) **Modification** – If modifications to a flowchart are required, it may require complete re-drawing.

(iii) **Reproduction** – Reproduction of flowcharts is often a problem because the symbols used in flowcharts cannot be typed.

(iv) **Link between conditions and actions** – Sometimes it becomes difficult to establish the linkage between various conditions and the actions to be taken there upon for a particular condition.

(v) **Standardization** – Program flowcharts, although easy to follow, are not such a natural way of expressing procedures as writing in English, nor are they easily translated into Programming language.

**Example 3:** Draw the Program Flowchart for finding the sum of first 100 odd numbers.

**Solution:** The flowchart is drawn as Fig. 1.9.4 and is explained step by step below. The step numbers are shown in the flowchart in circles and as such are not a part of the flowchart but only a referencing device.

Our purpose is to find the sum of the series 1, 3, 5, 7, 9.....(100 terms.) The student can verify that the 100th term would be 199. We propose to set A = 1 and then go on incrementing it by 2 so that it holds the various terms of the series in turn. B is an accumulator in the sense that A is added to B whenever A is incremented. Thus B will hold:

1

1 + 3 = 4

4 + 5 = 9,

9 + 7 = 16, etc. in turn.

**Step 1** - All working locations are set at zero. This is necessary because if they are holding some data of the previous program, that data is liable to corrupt the result of the flowchart.

**Step 2** - A is set at 1 so that subsequently by incrementing it successively by 2, we get the wanted odd terms: 1,3,5,7 etc.

**Step 3** - A is poured into B i.e., added to B. B being 0 at the moment and A being 1, B becomes 0 + 1 = 1.

**Step 4** - Step 4 poses a question. “Has A become 199 ?” if not, go to step 5, we shall increment A by 2. So that although at the moment A is 1, it will be made 3 in step 5, and so on. Then go back to step 3 by forming loop.

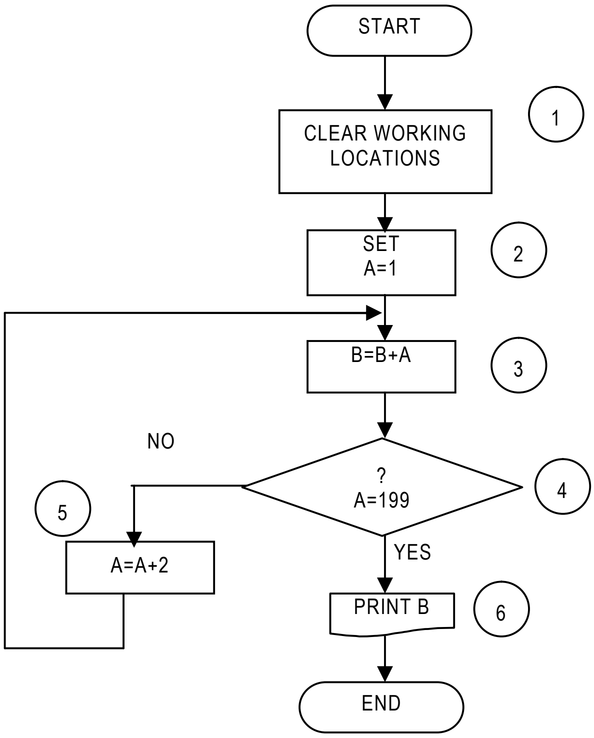



**Fig. 1.9.4: Flowchart for addition of first 100 odd numbers**

Since we have to stop at the 100th terms which is equal to 199, Thus, A is repeatedly incremented in step 5 and added to B in step 3. In other words, B holds the cumulative sum up to the latest terms held in A.

When A has become 199 that means the necessary computations have been carried out so that in step 6 the result is printed.

**Table 1.9.3: Differences between Flowchart and Data Flow Diagram**

| Flowchart | Data Flow Diagram |
|---|---|
| Flow chart presents steps to complete a process. | DFD presents the flow of data. |
| Flow chart does not have any input from or output to an external source. | DFD describes the path of data from an external source to internal source or vice versa. |
| The timing and sequence of the process is aptly shown by a flowchart. | Whether processing of data is taking place in a particular order or several processes are taking place simultaneously is described by a DFD. |

| | |
|---|---|
| Flow chart shows how to make a system function. | DFD define the functionality of a system. |
| Flow chart is used in designing a process. | DFD is used to describe the path of data that will complete that process. |
| Types of Flow charts – System, Data, Document and Program. | Types of DFD – Physical Data Flow and Logical Data Flow. |

Table 1.9.3 list major differences between Flowchart and Data Flow Diagram.

### 1.9.4 Decision Tree

A **Decision Tree** also termed as an **Inference** or **Logical tree** is a collection of a basis (condition) and a conclusion (action). In its tree-like representation, the premises and conclusions are shown as nodes, and the branches of the tree connect the premises and the conclusions. The logical operators "AND" and "OR" are used to replicate the structure of the if-then rules. As such, decision tables (DTs) do not seem to differ much from a decision tree.

A decision tree is a decision support tool that uses a tree-like graph or model of decisions and their possible consequences, including chance event outcomes, resource costs, and utility. It is one way to display an algorithm. Decision trees are commonly used in operations research, specifically in decision analysis, to help identify a strategy most likely to reach a goal.

Instead of specifying a table, the preference maker constructs a graph of the decision alternatives emanating as branches from a root node over a number leafs. A decision is the assortment between achievable actions. A choice is the range between two or more objects. Decision Trees are measured to be one of the most accepted approaches for representing classifier. Researchers from a variety of disciplines such as statistics, machine learning, pattern identification and data mining have dealt with the issue of growing a decision tree from available data. Decision trees are a simple, but powerful form of multiple variable analyses.

They provide unique capabilities to supplement, complement, and substitute for-

- traditional statistical forms of analysis (such as multiple linear regression)
- a variety of data mining tools and techniques (such as neural networks)
- recently developed multidimensional forms of reporting and analysis found in the field of business intelligence

**Advantages of using Decision Tree**

- Are simple to understand and interpret. People are able to understand decision tree models after a brief explanation.
- Possible scenarios can be added.
- Worst, best and expected values can be determined for different scenarios.

**Limitations of using Decision Tree**

- For data including categorical variables with different number of levels, information gain in decision trees are biased in favor of those attributes with more levels.
- Calculations can get very complex particularly if many values are uncertain and/or many outcomes are linked.

**Example 5**: Draw a Decision Tree for the below mentioned problem.

| PREDICTORS | | | | TARGET |
|---|---|---|---|---|
| **Outlook** | **Temperature** | **Humidity** | **Windy** | **Play Golf** |
| Rainy | Hot | High | False | No |
| Rainy | Hot | High | True | No |
| Overcast | Hot | High | False | Yes |
| Sunny | Mild | High | False | Yes |
| Sunny | Cool | Normal | False | Yes |
| Sunny | Cool | Normal | True | No |
| Overcast | Cool | Normal | True | Yes |
| Rainy | Mild | High | False | No |
| Rainy | Cool | Normal | False | Yes |
| Sunny | Mild | Normal | False | Yes |
| Rainy | Mild | Normal | True | Yes |
| Overcast | Mild | High | True | Yes |
| Overcast | Hot | Normal | False | Yes |
| Sunny | Mild | High | True | No |

**Solution:** Decision tree builds categorization or regression models in the shape of a tree structure. It breaks down a dataset into slighter and slighter subsets while at the same time an allied decision tree is incrementally developed. The concluding consequence is a tree with decision nodes and leaf nodes.

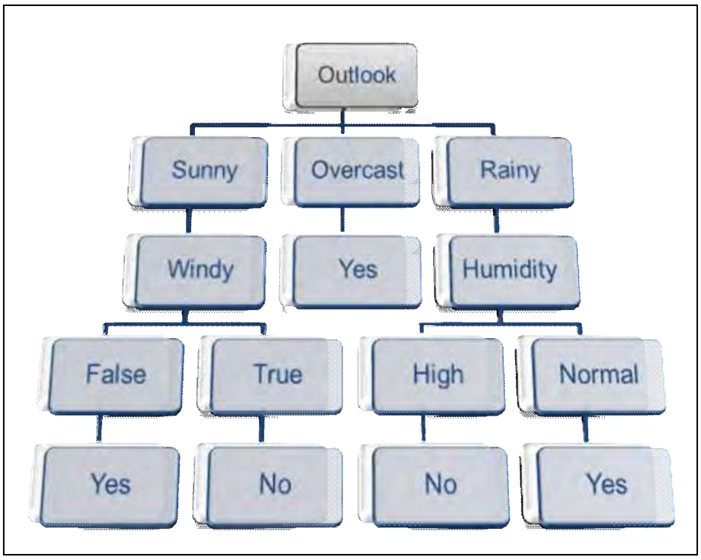



**Fig. 1.9.5: Decision Tree Conceptual View**

As shown in Fig. 1.9.5, the decision node (e.g., Outlook) has two or more branches (e.g., Sunny, Overcast and Rainy). Leaf node (e.g., Play) represents a categorization or decision. The uppermost decision node in a tree which corresponds to the greatest predictor called root node. Decision trees can grip both clear-cut and numerical data.

### 1.9.5 Decision Table

A **Decision Table** is a table which may accompany a flowchart, defining the possible contingencies that may be considered within the program and the appropriate course of action for each contingency. A Decision Table is divided into four parts:

i. **Condition Stub** - which comprehensively lists the comparisons or conditions;

ii. **Action Stub-** which comprehensively lists the actions to be taken along the various program branches;

iii. **Condition Entries** - which list in its various columns the possible permutations of answer to the questions in the conditions stub; and

iv. **Action Entries -** which lists, in its columns corresponding to the condition entries the actions contingent upon the set of answers to questions of that column.

A Decision Table is divided into four quadrants:

| | |
|---|---|
| **Condition Stub** | **Condition Entries** |
| **Action stub** | **Action Entries** |

A Decision Table is given below as an example:

| | | Granting Credit Facility | R1 | R2 | R3 | |
|---|---|---|---|---|---|---|
| Part 1 | C1 | Credit limit Okay | Y | N | N | Part 3 |
| | C2 | Pay experience Favorable | - | Y | N | |
| Part 2 | A1 | Allow Credit Facility | X | X | | |
| | A2 | Reject Order | | | X | Part 4 |

There are two conditions: C1 and C2 in this table and two actions: A1 and A2. According to R1 (a set of rules), if there is a "Yes" to C1 and C2 is to be bypassed, action A1 will be taken, that is, "Allow credit facility". Under R3, No's to both C1 and C2 requires action A2 to be taken. With this example, we give below the components of the decision table in more detail.

(a) **Condition Statement** - Statement which introduce one or more conditions (*i.e.,* factors to consider in making a decision)

(b) **Condition Entries -** Entries that complete condition statements.

(c) **Action Statements** - Statements which introduce one or more actions (*i.e.,* steps to be taken when a certain combination of conditions exist)

(d) **Action Entries** - Entries that complete the action statements.

(e) **Rules** - Unique combinations of conditions and actions to be taken under those conditions.

(f) **Header -** Title identifying the table.

(g) **Rule Identifiers** - Code (R1, R2, R3,) uniquely identifying each rule within a table.

(h) **Condition Identifiers** - Codes (C1, C2, C3...) uniquely identifying each condition statements/entry.

(i) **Action Identifiers** - Codes (A1, A2, & A3...) uniquely identifying each action statement/ entry

These items are contained within the body of the table which is divided into four major sections by double or heavy vertical and horizontal lines as in the table above.

**Steps in Preparing a Limited Entry Decision Table**

- List conditions and actions.
- Combine conditions which describe the only two possibilities of a single condition. In other words, delete conditions which can be derived from the responses of the other conditions.
- Make yes or no (Y or N) responses and mark actions to be taken for each rule with X.
- Combine redundant rules to simplify table.
- Check for completeness.

An example will be used to explain and illustrate the procedure.

**Example 6:** Select the largest of three distinct numbers A,B,C

**Solution:** Step 1 - Conditions involved in the problem is as follows:

1. A > B
2. A > C
3. B > A
4. B > C
5. C > A
6. C > B

Actions involved in the problem are as follows:

1. A is largest
2. B is largest
3. C is largest

*Step 2* - Conditions 1 & 3 can be combined; Conditions 2 & 5 can be combined and Conditions 4 & 6 can be combined

Therefore, there are only three conditions:

1. A > B
2. A > C
3. B > C

*Step 3* - No. of rules = $2^{nd}$ conditions = $2^3$ = 8

| | **Select Largest** | **R1** | **R2** | **R3** | **R4** | **R5** | **R6** | **R7** | **R8** |
|---|---|---|---|---|---|---|---|---|---|
| C1 | A > B | Y | Y | Y | Y | N | N | N | N |
| C2 | A > C | Y | Y | N | N | Y | Y | N | N |
| C3 | B > C | Y | N | Y | N | Y | N | Y | N |
| A1 | A is largest | X | X | | | | | | |
| A2 | B is largest | | | | | X | | X | |
| A3 | C is largest | | | | X | | | | X |

*R3 and R6 contain impossible combination of condition entries.

*Step 4* - R1 & R2 can be combined

R3 & R4 can be combined

R5 & R7 can be combined

R6 & R8 can be combined

| | Select largest | R1 | R2 | R3 | R4 |
|---|---|---|---|---|---|
| C1 | A > B | Y | Y | N | N |
| C2 | A > C | Y | N | — | — |
| C3 | B > C | — | — | Y | N |
| A1 | A is largest | X | | | |
| A2 | B is largest | | | X | |
| A3 | C is largest | | X | | X |

*Step 5* - All the rules in the reduced table have one dash. Therefore, the sum of the rules represented by rules in the reduced table is $2^1 + 2^1 + 2^1 + 2^1$ which is equal to $2^3$ or 8. No. of conditions is 3 and hence the No. of rules to be accounted for is $2^3$ or, 8. Therefore the reduced table is complete.

If problem has many conditions, the decision table may become quite large and difficult to follow. Since the objective of the table is to show the logic of the procedure as clearly and as simply as possible, a large, complex table should be avoided. In most cases, a large problem with many conditions can be subdivided into two or more tables. One or more of the actions of the first table will specify that the user should proceed to another table to complete the logic. An example is given to illustrate this use of more than one table.

## Advantages of using Decision Table

(i) **Easy to Draw –** Decision Tables are easy to draw and modify as compared to flowcharts.

(ii) **Compact Documentation –** The documentation in the form of decision tables is compact since one decision table may replace few pages of a flowchart.

(iii) **Simplicity –** It is easier to follow a particular path in one column of a decision table than it is to go through several pages of the flowcharts.

(iv) **Direct Codification -** The decision tables can be directly coded into a program.

(v) **Better Analysis –** A decision table shows various alternatives and their respective outcomes side by side for better analysis of the problem.

(vi) **Modularity –** The complex problems would require complex decision tables which can be easily broken down to micro-decision tables.

(vii) **Non-technical –** No knowledge of computer language or CPU working is necessary for drawing decision tables.

## Limitations of using Decision Table

(i) All programmers may not be familiar with Decision Tables and therefore flow charts are more common

(ii) Flowcharts can better represent a simple logic of the system rather than a decision table.

(iii) The decision tables do not express the total sequence of the events needed to solve the problem.

**Example 7:** A technical support company writes a decision table to diagnose printer problems based upon symptoms described to them over the phone from their clients.

**Solution:** The decision Table is shown in the Table 1.9.4.

**Table 1.9.4: Printer troubleshooter**

| | | Rules | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Conditions** | Printer does not print | Y | Y | Y | Y | N | N | N | N |
| | A red light is flashing | Y | Y | N | N | Y | Y | N | N |
| | Printer is unrecognized | Y | N | Y | N | Y | N | Y | N |
| **Actions** | Check the power cable | | | X | | | | | |
| | Check the printer-computer cable | X | | X | | | | | |
| | Ensure printer software is installed | X | | X | | X | | X | |
| | Check/replace ink | X | X | | | X | X | | |
| | Check for paper jam | | X | | X | | | | |

## 1.10 Summary

"Process thinking" is the new approach to solving business problems. In this chapter we have learned how viewing an organization as a system of set of interlinked processes rather than functional silos could bring about significant improvements in the overall performance of the business and help in achievement of organizational objectives. Businesses are a collection of connected processes and that to be agile, those processes must frequently be realigned or reconnected so they can address changing business environments, redefined business objectives and newly imposed regulations.

Business Process Management (BPM) is a holistic approach for aligning business processes with the needs of the customers. The idea is to view processes as assets that provide value to customers. Hence a systematic approach to continuously improve the business processes through innovation, integration and use of technology is essential to ensure survival of the business as well as improvement in business effectiveness and efficiency.

BPM systems allow organizations to devise process centric information technology solutions. Process-centric means BPM solutions are able to integrate people, systems, and data. BPM solutions enable business users, analysts, managers and other stakeholders to collaborate with developers in implementation process through the - Business Process Management

Lifecycle. Different levels can be identified in business process management, ranging from high-level business strategies to implemented business processes.

BPM can be applied in many disparate ways, depending on the sector in which it is being used. Several approaches to mapping business processes may be adopted including entity relationship diagrams, data flow diagrams, systems flow diagrams, system outline charts, decision trees, decision tables, etc. The purpose of mapping is to define clearly the activities involved in a business process and to find opportunities for improvements in the current process.

Business Process Reengineering (BPR) aims at major transformation in business processes to achieve dramatic improvements. Here, the business objectives of the enterprise are achieved by “transformation” of business processes which may, or may not, require the use of Information Technology (IT).

The Payback achieved by industries through implementing BPM need be quantitatively assessed to identify the areas of improvement. The numerous stumbling-blocks that organizations face with BPM systems are due to inadequate investment in ongoing training for involved personnel, including those implementing and testing changes, as well as a lack of corporate policy protecting the integrity of the data in the BPM systems and the way it is used.

# 2

# Information Systems and IT Fundamentals

| Learning Objectives |
|---|
| ♦ To understand the need for Information Technology (IT) in business organizations and its relevance in Auditing; |
| ♦ To explain Business Process Automation (BPA) and understand the role of BPA in improving the business processes; |
| ♦ To understand the term 'Computing' and various popular computing architectures; |
| ♦ To understand Information System Layers - different layers of interaction in an Information System; |
| ♦ To explain Information System Life Cycle and the process of building Information Systems; and |
| ♦ To have an overview of recent technologies. |
| **Task Statements** |
| ♦ To demonstrate the need for IT in business and its relevance in Auditing; |
| ♦ To demonstrate the benefit of BPA in Business Process Management; |
| ♦ To identify different disciplines of the computing field; |
| ♦ To identify different layers of Information Systems and their functions; |
| ♦ To review activities of different phases of Information System Life Cycle; |
| ♦ To identify different aspects of computing technologies; Cloud computing, Mobile computing etc., and their functioning; and |
| ♦ To identify some of the recent technologies/devices and their impact in organizations. |
| **Knowledge Statements** |
| ♦ To know the need for IT and its advantages to business like communication capabilities, data and information management and automated processes; |

- To know the importance and impact of IT in Auditing;
- To know the Business Process Automation: Knowledge of deployment of BPA and how it complements Business Process Management;
- To know the definition of Computing and its sub-disciplines;
- To know Information System Layers: Knowledge of Information System layers, their functions, their types and the basic advantages and disadvantages of deploying them;
- To know Information System Life Cycle: Knowledge of the phases involved in the development of Information Systems;
- To know various computing technologies such as servers, end points and popular computing architectures; and
- To know the Emerging Technologies: Knowledge of computing architectures & delivery models such as: SaaS, Cloud Computing, Mobile computing, etc.

## 2.1 Introduction

Information Systems (IS) are the foundation for conducting business today. For many enterprises, existence without extensive use of information systems is inconceivable (imagine Google without IS). IT plays a critical role in increasing operational excellence, customer and supplier intimacy, improved decision making and competitive advantage. When IT is integrated throughout the enterprise and linked with management, it can provide the foundation for new products, services and ways of conducting business result in strategic advantage.

In the past, people could rely on manual processes to make decisions because they had limited amounts of information to process. Today, due to the new technologies of communication convergence, more and more relevant data is available with enterprises. While it is expected to help in arriving at more informed and appropriate decisions of various kinds, at the same time it is almost impossible for people to make decisions without the aid of information systems. Highly complex decisions must be made in increasingly shorter time frames. Adoption of IT is imperative today for running any business.

The business enterprises initially used IT for various data processing functions. Now, we see a completely transformed working environment with IT playing a major role in almost all spheres of activities. Concepts of Business Process Automation (BPA) today form an integral part of any existing corporate environment with a substantial impact on business workflow to the bottom-most level. Any BPA is both a business process and an IT component. The IT component is crucial and is composed of computers as well as communication technologies which we need to understand. Businesses rely on information systems to carry out and manage their operations, interact with their customers and suppliers, and compete in the marketplace.

Developing any information system involves various defined phases commonly called as System Development Life Cycle. The whole of information flow in any information system involves layers of hardware, software (both Application as well as System), Database Management Systems and networks used to deliver the solution to the final consumer of services. These layers and the interaction amongst these layers have to be understood.

We also need to understand various computing technologies and their components to truly appreciate the working of Information Systems. Understanding IT provides great insight to anyone learning about business and also how IT is creating efficiencies and effectiveness across the enterprise. Any individual anticipating a successful career in business, whether it is in accounting, finance, or operation management, must understand information technology and ultimately information systems.

Let us understand how IT was used by as a game-changer in an Indian Company. For example, in early 90s, Mahindra & Mahindra realized that it had established different departments, which had their own information but had become islands of information. ERP implementation by the company helped in restructuring its business processes and integrating various business functions ultimately leading to better procurement cycles & reducing wastages. Company also launched its intranet, Mahindra Connect, to provide a platform for sharing company & employee related information. Thus, IT became the back-bone of enterprise operations providing the company providing strategic and competitive advantage.

## 2.2 Need for Information Technology

Understanding how IT is deployed in enterprises is imperative to learning about business. IT in the present context may be referred to as a computer-based tool that people use to work with information and support the information-processing needs of an enterprise. IT allows enterprises to work more efficiently and to maximize productivity. Faster communication, electronic storage and the protection of records are advantages that IT can give to any enterprise. From multi-national corporations which maintain mainframe systems and databases to small businesses that own a single computer; IT has a role to play everywhere.

IT enables business enterprises to differentiate their products and services from that of their competitors. Those enterprises that leverage IT for competitive advantage often differ from their competitors in two ways:

- They view IT as a strategic business enabler instead of viewing it as a cost component.
- They work to maximize the efficiency of their IT operations so that they can focus their resources to providing value and responding to rapidly changing business conditions.

If we look at the reasons for the all-pervasive use of IT for business, they would be:

- Communication Capabilities;
- Data and Information Management; and
- Automated Processes.

### 2.2.1 Communication Capabilities

IT provides resources to enterprises to communicate quickly and effectively. With these communication capabilities, enterprises can now integrate their business functions and segments spread across different geographical areas. Any global enterprise having an international presence can integrate its far flung business locations using communication capabilities offered by IT.

Enterprises these days are equipped with email, video conferencing equipment and internal chat rooms which provide an efficient way to communicate and conduct business. Emails provide a simple and inexpensive way to communicate with clients or customers as well as vendors. Communication through email is faster and cost less than sending paper letters via postal mail.

Over the years, a number of other communication tools have evolved, allowing staff to communicate using live chat systems, online meeting tools and video-conferencing systems. **Voice Over Internet Protocol (VOIP)** telephones and smart-phones offer even more high-tech ways for employees to communicate. Skype is one such popular VOIP service, which allows people across the world to make free, unlimited, superior quality voice calls via its innovative peer-to-peer software.

Similarly **WhatsApp Messenger** is a cross-platform mobile messaging application which allows us to exchange messages without having to pay for SMS. It is available for: iPhone, BlackBerry, Android, Windows phone, Nokia and these phones can message each other. Because WhatsApp Messenger uses the same internet data plan that we use for e-mail and web browsing, there is no cost to message and stay in touch with friends.

Recently many companies have started using a special kind of software, known as **Team-ware**, **Collaboration Software** or **Groupware**. This software allows collective and collaborative working of teams from different geographical locations on an online and real-time basis.

### 2.2.2 Data and Information Management

The days of large file rooms, rows of filing cabinets and the mailing of documents are fast fading away. Today, most enterprises store digital versions of documents on servers, storage devices and on cloud. These documents are instantly available to anyone with access rights, regardless of their geographical location. Thus enterprises are able to store and maintain a tremendous amount of historical data economically and employees benefit from immediate access to the documents they need.

Further, IT also enables Information Security, which is a broad term encompassing the protection of information from accidental or intentional misuse by persons inside or outside an enterprise. IT security engineering systems protect enterprise electronic information from being hacked, or wiped out during a technological disaster. IT Security is perhaps the most fundamental and critical of all the technologies/disciplines an enterprise needs to implement appropriately by executing its business strategy so as to be able to not only survive but thrive in the digital age. Without appropriate security processes and procedures, none of the other technologies can give business advantages. Authentications and passwords limit access to confidential information. Using a program, information can be encrypted in a way to prevent unauthorized use, making it quite safe and secure. A lost, stolen or misplaced laptop or desktop computer can be tracked using security software that can be activated remotely.

## 2.3 Importance of IT in Auditing

IT is all pervasive and the impact is extensive for enterprises, professionals and individuals. IT encompasses all aspects of functioning of enterprises from strategy to operations, conception to completion and from ideation to value creation. Business, regulatory and competitive requirements are demanding innovation in technology deployment resulting in changing business models of delivery of services using diverse digital media. Successful enterprises in the digital age are those which create positive customer experience and make this their business lifeline. IT is crucial for delivering a positive customer experience and this in turn drives revenue and growth. Enterprises, professionals as individuals are becoming increasingly dependent on IT and need to knowingly or unknowingly embrace IT. Information Technology is evolving at an accelerating pace and the role of IT is transforming business processes. It is expected that role of IT in enterprises will fundamentally change from being a service provider to IT becoming a Service Broker, aggregator of services and primarily responsible for building, maintaining and sustaining the business relationship by rendering core services to the customer.

Accountants and Auditors in their various roles ranging from accounting to auditing have to use and embrace technology to perform their jobs effectively and efficiently. They deal with data in myriad forms for analysis and decision-making. The location of digital data could be traced to computers and servers either at identified offices of clients or vendors. The increasing digitization of data leads to an increasing impact and exerts continuing pressure on Accountants and Auditors to expand their skills beyond traditional roles of using IT for office automation to providing innovative services harnessing the power of technology. The dynamic changes in IT create challenges in not only enterprises but also accountants and auditors in their professionals' capacity.

The traditional core competencies of auditors needs to be enhanced with increased understanding of technology systems and there is urgent need to develop the ability to process and integrate information among various areas of business practice. Auditors of the future will be called upon to provide solutions to complex issues by integrating specialized technology with their extensive experience to create new strategic business processes. Auditors will have to provide assurance on the security, effectiveness, and reliability of information, applications, and new and effective business practices and processes. As IT increasingly becomes a key enabler in enterprises of all types and sizes; and there is transformation from "Technology Oriented" to "Business and Technology Oriented".

### 2.3.1 Auditing in IT Environment

Traditional methodology of audits had an audit trail which assisted the auditors in conducing and documenting the audit. However, the distinction in concepts between a manual environment and a computer based environment are highlighted below:

Auditing in a computerized environment would depend on the scope and objective of audit. However, audit broadly would involve the process of evaluating and reporting the adequacy of system controls, efficiency, economy, effectiveness, and security practices to assure that assets and information resources are safeguarded, that data integrity is protected, and that the system complies with applicable policies, procedures, standards, rules, laws and regulations. The auditor has to look at both manuals and automated parts of the system because of their interfacing nature.

**The Audit Objectives**

The objectives of Audit would vary depending on the type, purpose objective and scope of audit. However, the general objectives of auditing in a computerized environment could include the following objectives of manual (external/internal) audit although the extent of coverage could vary based on scope and objectives:

- **Existence:** Verify that the assets, liabilities, ownership, and/or activities are real;
- **Authorization:** Verify that events have occurred in accordance with management`s intent;
- **Valuation:** Verify that the accounting values fairly present items worth;
- **Cutoff:** Verify that the transaction is re-coded in the proper accounting period;
- **Compliance:** Verify that the processing is in compliance with governmental laws and regulations, generally accepted accounting procedures, and the organization`s policies and procedures;
- **Operational:** Verify that the program, area, or activity is performed economically, efficient, and effectively;
- Assisting management in finding ways to implementing internal control recommendations;
- Participating in specifying and designing computer control and other features for systems to be installed;
- Determining whether efficient use is made of the organization's Computer resources; and
- Determining whether Computer system used accomplishes the business objectives and goals.

Differences in audit procedures are given as follows:

- **Study Technical Aspects:** Gather evidential matter relating to technical aspects of systems under study, including all relevant documentation describing the computer facility, application programs, operating procedures, security procedures and so on. The focus is to begin from the peripheral controls (general controls) to application's controls.

- **Use Unique Techniques:** Audit in a computerized environment would require application of unique techniques to these efforts. For example, the audit planning step includes review of technical documentation and interviewing technical specialists. The auditor must understand the procedures for testing and evaluating Computer Controls.
- **Audit Software Usage:** These procedures include the use of generalized audit software to survey the contents of data files, the use of specialized software to assess the contents of operating system parameter files and flow-charting techniques for documenting the automated applications.

### 2.3.2 IT Risks and Issues

Regulations are making it mandatory for auditors to review the structure and systems of governance and risk management which is embedded in IT in most enterprises. A key requirement of enterprises in IT deployment is to ensure that business objectives are achieved and not mere implementation of latest technology. A key challenge in implementing IT is: "**Higher the technology, Greater is the need for controls"**. Hence, it becomes critical for enterprises to implement IT not only with right security but also to create business value. Auditors can play a critical role in reviewing security and facilitating enterprises to realize business value. The scope and objective of assurance do not change with technology but the way controls are reviewed is drastically changed. Auditors with their in-depth knowledge and core competencies in business process and internal control are uniquely positioned to provide assurance and consulting services in IT area.

Enterprise risks include several components such as business risks, technology risks, operational risk and other risks. An overview of technology risks is discussed here. Technology risks are faced by enterprises that are heavily driven by and dependent on technology, especially where the types of technology used are rare and keep changing. When the technology used fails or becomes obsolete, the enterprise may not be able to continue with its business. Some of the issues that these enterprises have to deal with are following:

- What type of process will the enterprise use to identify the business and technology risks when changes in technology occur (whether they arise from the use of new types of services, or from changes in equipment for existing services)?
- What are the risks faced by the enterprise when it makes changes to a critical system (or systems) which cannot afford to fail?

### 2.3.3 Need for Controls in Information Systems

Technology has impacted what can be done in business in terms of information as a business enabler. It has increased the ability to capture, store, analyze and process tremendous amounts of data and information by empowering the business decision maker. With the advent of affordable hardware, technology has become a critical component of business. Today's dynamic global enterprises need information integrity, reliability and validity for timely flow of accurate information throughout the organization. Safeguarding assets to maintain data integrity to achieve system effectiveness and efficiency is a significant control process.

A well designed information system should have controls built-in for all its sensitive or critical sections. For example, the general procedure to ensure that adequate safeguards over access to assets and facilities can be translated into an Information Systems related set of control procedures, covering access safeguards over computer programs, data and any related equipment. Information Systems control procedure may include the following:

- Strategy and direction;
- General Organization and Management;
- Access to IT resources, including data and programs;
- System development methodologies and change control;
- Operation procedures;
- System Programming and technical support functions;
- Quality Assurance Procedures;
- Physical Access Controls;
- Business Continuity Planning(BCP) and Disaster Recovery Planning (DRP);
- Network and Communication;
- Database Administration; and
- Protective and detective mechanisms against internal and external attacks.

### 2.3.4 Special features of auditing in an IT environment

Computer based Information Systems contains four interdependent elements: **Hardware, Software, People** and **Procedures.** All these four elements interact to process or convert data into information. Data is the accumulated but unorganized facts. Information is the usefully organized and reported facts which is usually generated (output) from the data (input) using the computer (hardware) as per the procedures (Software) laid down by the management (people).The awareness required by an Auditor for auditing in a IT environment are to:

- know the Methodology of Audit so to ensure that the standards, proper usage of common procedures and techniques in the performance of audits is adhered to.
- understand the steps and techniques necessary to plan, perform and complete the Audit.

### 2.3.5 Impact of IT on Risks and Controls

Data handling capacity of computer combined with telecommunications technology greatly increases ability of an individual to access and perhaps to manipulate large quantities of data -

within a relatively short time period: thus, increasing amount of potential damage or risk of exposure.

- Ready access to terminals as computerized Information Systems are highly distributed and leads to ease in perpetration of computer related crimes thereby increasing temptation for abuse.
- On-line processing of data and validation checks would help the prospective perpetrator in guessing passwords and aid in circumventing controls in inputs to computer.
- Appropriate controls are not resident within the computer systems to detect or to prevent the accidents. If threats are not anticipated and adequate controls are not designed to mitigate or counter them, system and its resources will be vulnerable.
- The greatest exposure of all is a failure to recognize risks or potential impacts of those risks. Prudence demands that contingencies are to be anticipated and planning done to handle them.

The four major areas in which controls have been affected are:

- Realignment of functions data entry and source of transactions may be centralized;
- Changes in custody of files and documents. Ready access to data over telecom links complicate custodial functions of data. Data librarian may become in charge for data;
- Transfer of responsibilities Single action by user may complete the entire processing cycle of the transaction; and
- Decline of accountability Traditional functions, responsibilities and boundaries have been eliminated or are obscured by new methods.

### 2.3.6 Auditors' Concern

The increased risks and changes in traditional control functions lead to a shift in the auditors concern. The key concerns of auditor are as follows:

- Develop and apply new criteria in evaluating control weaknesses in Computerized Information Systems (CIS);
- Tailor testing techniques to the CIS under study; and
- Use computers to perform some portions of audit examination.

*For more detailed discussion on relevance of IT in Auditing, students may refer the Study Material of 'Auditing and Assurance' Paper of Intermediate (IPC) Course.*

## 2.4 Overview of Business Process Automation

If we take a close look at some of the workflow process or daily activities that employees usually perform to run the business operations, we will find that several of these tasks performed are repetitive, as well as, tedious. Repeated manual data manipulation is rarely an efficient use of resources and most easily demonstrates the value of the BPA concept. Basic tasks that currently use human intervention, such as purchase order processing can often be delayed until the specific employee tasked with handling that process is available, these kinds of tasks could easily be automated.

The role of management for any business is to maximize their shareholders' ROI (Return On Investment). In order to achieve this goal, firms must identify any unnecessary amount of work and eliminate inefficient labor. Business workflow is a task-based process. From simple data entry to the more complex manipulation of that data, we can almost always define the business workflow process as a series of discrete tasks. Various combinations of these discrete tasks make up the business processes. These tasks can be broken down into their component actions, which mean that they can be automated. Efficiently and effectively automating these types of tasks is what BPA is all about.

At its simplest, **Business Process Automation (BPA)** may be defined as the automation of business processes. In other words, it may be defined as removing the human element from existing business processes by automating the repetitive or standardized process components. On its own, BPA automates processes that are part of business function.

To achieve this automation, we would need IT infrastructure, hardware and software to manage the same. Further, all the systems have to be networked so that information can flow seamlessly. In addition, the need would be for database so that the data and information can be stored and retrieved in a desired and appropriate manner. If we now look at IT perspective then we can also visualize the following IT processes, which are usually involved in a typical business enterprise:

- **Database access and changes:** It provides access to data via ODBC (Open DataBase Connectivity) connections, data updates, and file transfers.
- **File replication and data backup:** It protects valuable data by backing up databases and key systems.
- **Systems and event log monitoring:** It reviews and analyzes the event log and critical systems, and create multistep corrective action, such as restarting a server service. With BPA, these processes run automatically when certain events occur.
- **Job scheduling:** It automates processes that perform a variety of daily or unscheduled tasks.
- **Application integration:** It automates IT and business processes by combining applications that drive business. Complex processes such as database queries, data transformation and spreadsheet integration can be automated.
- **File transfers:** It can be automated to deliver and retrieve data on set schedules.
- **Printing:** It is automated to simplify print jobs.

BPM and BPA are complementary technologies and concepts, but we can use BPA to make existing processes more efficient, not only at enterprise level but even for desktop users' through simple workflows, access and authorizations. Deploying a BPA solution can be the first step in a corporate BPM deployment. BPM aims to improve process agility, operational excellence and cost efficiency by capturing the total picture of all workflows involved in a business process.

BPA solutions feature three critical pillars – **Orchestration**, **Integration**, and **Automation**. Tight coupling of these elements enables organizations to streamline and automate business processes regardless of scope, scale, and complexity. BPA application ties up the following activities:

- **Integration:** BPA allows applications and operating systems not only to read data that the systems produce, but also to pass data between the component applications of the business process and to modify the data as necessary.
- **Orchestration:** The process of orchestration enables the ability to bring tasks that exist across multiple computers and different business departments or branches under one umbrella that is the business process itself.
- **Automation:** Orchestration and integration unite with automation to deliver the capability to provide a rules-based process of automatic execution that can span multiple systems and enable a more effective, nimble and efficient business process.

BPA can make the business processes faster and more efficient, robust, and flexible. The approach to business process automation entails understanding how information is collected and processed on a day-to-day basis and then making recommendations on how best to automate those processes for maximum benefit. The steps involved in any BPA are as follows:

- Step 1: Define why we plan to implement BPA?
- Step 2: Understand the rules/ regulation under which it needs to comply with?
- Step 3: Document the process, we wish to automate.
- Step 4: Define the objectives/goals to be achieved by implementing BPA.
- Step 5: Engage the business process consultant.
- Step 6: Calculate the ROI for project.
- Step 7: Development of BPA.
- Step 8: Testing the BPA.

Business Process Automation can be largely aided by Enterprise Resource Planning (ERP) that enables companies to replace traditional business silos with tightly integrated structures that encompass internal processes, human resources, and technology and enterprise strategy. Activities that are typically covered by ERP include accounting, sales/marketing/client management, purchase management, production management, costing, inventory control and human resources management.

*For further details of these aforementioned steps, students may refer Chapter-5 "Business Process Automation through Application Software" of the Study Material of Intermediate (IPC) Course.*

## 2.5 Overview of Computing

The term 'Computing' has a great significance in IT related aspects. These are various definitions given by the experts/organisations worldwide, out of these; one of the most popular definitions is given by ACM, which defines "Computing as any goal-oriented activity requiring, benefiting from or creating computers. Thus, computing includes designing and building hardware and software systems for a wide range of purposes; processing, structuring, and managing various kinds of information; doing scientific studies using computers; making computer systems behave intelligently; creating and using communications and entertainment media; finding and gathering information relevant to any particular purpose, and so on. The list is virtually endless, and the possibilities are vast."

It defines five sub-disciplines of the computing field, which are briefly explained here:

- Computer Science,
- Computer Engineering,
- Information Systems,
- Information Technology, and
- Software Engineering.

**Computer Science:** It refers to the scientific and practical approach to computation and its applications. It is the systematic study of the feasibility, structure, expression, and mechanization of the methodical processes (or algorithms) that underlie the acquisition, representation, processing, storage, communication of, and access to information, whether such information is encoded in bits and bytes in a computer memory or transcribed in genes and protein structures in a human cell.

**Computer Engineering:** It refers to the discipline that integrates several fields of electrical engineering and computer science required to develop computer hardware and software. Computer engineers are involved in many hardware and software aspects of computing, from the design of individual microprocessors, personal computers, and supercomputers, to circuit design. This focuses not only on how computer systems work but also how they integrate and work a holistic system.

**Information System (IS):** It refers to the study of complementary networks of hardware and software that enterprises, employees or individuals use to collect, process, create, store and distribute data. Any specific Information System aims to support operations, management and decision making. Information System also refers to not only Information and Communication Technology (ICT) that an enterprise uses but also to the way in which staff, customers and vendors interacts with ICT to facilitate business processes in an integrated manner.

**Information Technology (IT):** It refers to the application of computers and telecommunications to store, retrieve, transmit and manipulate data in for processing of information in enterprises. Generally, IT encompasses not only computers and computer networks but also other information distribution technologies such as television and telephones. IT industry in general is supported by multiple industry sectors such as computer hardware, software, electronics, semi-conductors, internet, telecom equipment, e-Commerce and computer services. In a business context, the Information Technology Association of America has defined Information Technology as "the study, design, development, application, implementation, support or management of Computer-Based Information Systems". The responsibilities of those working in the field include network administration, software development and installation, and the planning and management of an organization's technology life cycle, by which hardware and software is maintained, upgraded and replaced.

**Software Engineering:** It refers to the application of a systematic, disciplined, quantifiable approach to the design, development, operation, and maintenance of software, and the study of these approaches, which is primarily the application of engineering to software.

Enterprises use IT to provide information systems, which process and provide information to users. As accountants and auditors, we are primarily concerned and need to be well versed with the disciplines of Information Systems and Information Technology in their practical deployment.

## 2.6 Computing Technologies

Brief overview of some of the key computing technologies is given as follows:

### 2.6.1 Server

From a hardware perspective, a server is a computer (Hardware) or device on a network dedicated to run one or more services (as a host), to serve the needs of the users of other computers on a network. However in the context of client-server architecture, a server is a computer program running to serve the requests of other programs, the "clients". Thus, the server performs some computational task on behalf of "clients." The clients either run on the same computer, or they connect through the network.

Servers are often dedicated, meaning that they perform no other tasks besides their server tasks. On multiprocessing operating systems, however, a single computer can execute several programs at once. A server in this case could refer to the program that is managing resources rather than the entire computer. Essentially it is not the size of a computer system that makes it a server. It is in-fact based on the function that it provides. Any computer system that provides some sort of service can be referred to as a server.

There are different types of servers, based on the nature of service they provide. Some of them are given as follows:

- **File server:** This is a computer and storage device dedicated to storing files. Any user on the network can store files on the server.

- **Print server:** This is a computer that manages one or more printers.
- **Network server:** This is a computer that manages network traffic.
- **Database server:** This is a computer system that processes database queries.
- **Application Server:** This is a program that handles all application operations between users and an enterprise's backend business applications or databases.
- **Web Servers:** Web servers are computers that deliver (serves up) web pages. Every web server has an IP address and possibly a domain name. For example, if we enter the URL http://www.icai.org in our browser, this sends a request to the Web server whose domain name is icai.org. The server then fetches the home page named and sends it to our browser. Any computer can be turned into a Web server by installing server software and connecting the machine to the Internet.
- **Mail Server:** Mail servers move and store mail over corporate networks.

Let us look at the case study of an Indian Company relating to usages of servers:

The Indian Rayon unit of the Aditya Birla Nuvo group is the second largest producer of Viscose Filament Yarn (VFY) in India, in terms of its market share. But, with the financial crisis, there was pressure on the IT team to contain costs. The best way to do that was to consolidate its servers. They conducted a study on the different servers being used and their deployment and based on study consolidated the servers as required there by eliminating redundancy and reducing cost.

### 2.6.2 Popular Computing Architecture

The computer is based on a fixed hardware platform, capable of executing a fixed repertoire of instructions. At the same time, these instructions can be used and combined like building blocks, yielding arbitrarily sophisticated programs. Importantly, the logic of these programs is not embedded in the hardware platform. Instead, the program's code is stored and manipulated in the computer memory, just like data, becoming what is known as "software". Since the computer's operation manifests itself to the user through the currently executing software, the same hardware platform can be made to behave completely differently each time it is loaded with a different program.

In Computer Engineering, **Computer Architecture** can be defined as the science and art of selecting and interconnecting hardware components to create computers that meet functional, performance and cost goals. It is the technical drawings and functional description of all design requirements (especially speeds and interconnections); it is how to design and implement various parts of a computer focusing largely on the way by which the Central Processing Unit (CPU) operates internally and how it accesses addresses in memory.

Computer architecture includes at least three main subcategories:

(i) **Instruction Set Architecture (ISA)**

**Instruction set** is the set of machine code instructions that the processor can carry out. CPU (Processor), the centre piece of the computer's architecture, is in charge of executing the instructions of the currently loaded program. Each processor has its own unique instruction set specifically designed to make best use of the capabilities of that processor. These instruction set tells the processor to carry out various calculations, to read and write values from and into the memory, and to conditionally jump to execute other instructions in the program.

**Instruction Set Architecture** is the abstract model of a computing system that is seen by a machine language programmer including the instruction set; memory address modes; processor registers; and address and data formats. Basically Instruction Set Architecture (ISA) is related to the programming of a computer – that is, how the computer understands what each element in its basic language means, what instructions are to be carried out and in what order, etc. The ISA basically deals with what the chip does. It's a sort of 'bridge' between software and hardware. Understanding how it all works requires knowledge of the structure of a computer and its assembly language. The instructions may be Data Movement Instructions, Transfer of Control, Arithmetic/Logical Instructions; Input/output and some miscellaneous instructions that handle interrupts and activities.

**Fixed and Variable length Instructions**

Instructions are translated to machine code. In some architecture, all machine code instructions are the same length i.e. fixed length. In other architectures, different instructions may be translated into variable lengths in machine code.

Variable length instructions are commonly used on CISC machines. The advantage of using variable length instructions is that each instruction can use exactly the amount of space it requires, so that variable length instructions reduce the amount of memory space required for a program.

On the other hand, it is possible to have fixed length instructions, where as the name suggests, each instruction has the same length. Fixed length instructions are commonly used with RISC processors. Since each instruction occupies the same amount of space, every instruction must be long enough to specify a memory operand, even if the instruction does not use one. Hence, memory space is wasted by this form of instruction. The advantage of fixed length instructions is that they make the job of fetching and decoding instructions easier and more efficient, which means that they can be executed in less time than the corresponding variable length instructions.

In general, computer programs that execute very quickly tend to use larger amounts of storage, while programs to carry out the same tasks, that do not use so much storage, tend to take longer to execute.

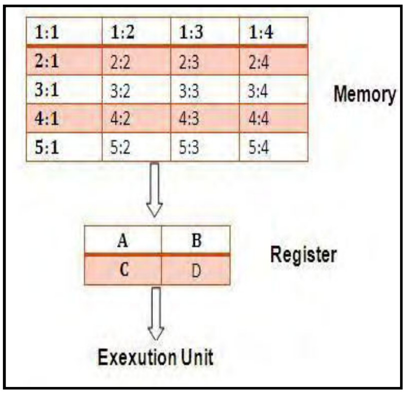
**Classification of Instruction Sets**

An important aspect of computer architecture is the design of the instruction set for the processor. The instruction set chosen for a particular computer determines the way that machine language programs are constructed. These are of basically two types, which are given as follows:

- **Complex Instruction Set Computer (CISC):** If the control unit contains a number of micro-electronic circuitry to generate a set of control signals and each micro-circuitry is activated by a micro-code, this design approach is called CISC design. Examples of CISC processors are: Intel 386, 486, Pentium, Pentium Pro, Pentium II, Pentium III processors etc. CISC chips have a large, variable length and complex instructions and generally make use of complex addressing modes. Different machine programs can be executed on CISC machine. Since CISC processors possess so many processing features, the job of machine language programmers becomes easier. But at the same time, they are complex as well as expensive to produce. Now-a-days, most of the personal computers use CISC processors.
- **Reduced Instruction Set Computer (RISC):** To execute each instruction, if there is separate electronic circuitry in the control unit, which produces all the necessary signals, this approach of the design of the control section of the processor is called RISC design. It is also called hard-wired approach. Examples of RISC processors: IBM RS6000, MC88100 processors etc. RISC processors use a small and limited number of instructions and mostly use hardwired control unit. These consume less power and are having high performance. RISC processors use simple addressing modes and RISC instruction is of uniform fixed length. Since RISC processors have a small instruction set, they place extra demand on programmers. However, RISC processors are faster, less complex and less expensive than CISC processors because of their simpler design. Since RISC design uses more lines of code hence, more RAM is needed to store the assembly level instructions. Also, the compiler must also perform more work to convert a high-level language statement into code of this form.

**RISC vs CISC – An Example of multiplication of two numbers in memory.**

Suppose that the main memory is divided into locations numbered from (row) 1: (column) 1 to (row) 5: (column) 4. The execution unit is responsible for carrying out all computations. However, the execution unit can only operate on data that has been loaded into one of the four registers (A, B, C, or D). Let's say we want to find the product of two numbers - one stored in location 1:3 and another stored in location 4:2 and store back the result to 1:3.




**CISC Approach**

CISC design would try to finish the task in the minimum possible instructions by implementing hardware which could understand and execute series of operations. Thus the processor would come with a specific instruction 'MUL' in its instruction set. 'MUL' will load the two values from the memory into separate registers, multiplies the operands in the execution unit, and then stores the product in the appropriate location. So, the entire task of multiplying two numbers can be completed with one instruction:

**MUL 1:3, 4:2**

MUL is referred to as a "complex instruction" as it operates directly on the computer's memory banks and does not require the programmer to explicitly call any loading or storing functions.

**RISC Approach**

RISC processors use simple instructions that can be executed within a clock cycle. Thus, 'MUL' instruction will be divided into three instructions.

(i) "LOAD," which moves data from the memory bank to a register,

(ii) "PROD," which finds the product of two operands located within the registers, and

(iii) "STORE," which moves data from a register to the memory banks.

In order to perform the task, a programmer would need to code four lines of assembly:

```
LOAD A, 1:3
LOAD B, 4:2
PROD A, B
STORE 1:3, A
```

(ii) **Micro Architecture**

**Micro Architecture**, also known as **Computer Organization**, is a lower level detailed description of the system that is sufficient for completely describing the operation of all parts of the computing system, and how they are inter-connected and inter-operate in order to implement the ISA. This describes the data paths, data processing elements and data storage elements, and describes how they should implement ISA. The Micro architecture can be seen as how the ISA does and what it does. It's how everything is ultimately organized on the chip or processor.

Micro architecture is the term used to describe the resources and methods used to achieve architecture specification. The term typically includes the way in which these resources are organized as well as the design techniques used in the processor to reach the target cost and performance goals. The micro architecture essentially forms a specification for the logical implementation.

(iii) **System Design**

It includes all of the other hardware components within a computing system such as:

- **System interconnects-Computer buses and switches: Computer Bus** is a communication system that transfers data between components inside a computer, or between computers that covers all related hardware components (wire, optical fiber, etc.) and software, including communication protocol.

- **Memory controllers and hierarchies:** The **Memory Controller** is a digital circuit which manages the flow of data going to and from the main memory and can be a separate chip or integrated into another chip.
- **CPU off-loads mechanisms - Direct Memory Access (DMA): Direct Memory Access (DMA)** is a feature of modern computers that allows certain hardware subsystems within the computer to access system memory independently of the central processing unit (CPU).
- **Issues-multi-processing, virtualization, software features etc**.
  - **Multiprocessing** is the use of two or more Central Processing Units (CPUs) within a single computer system to allocate tasks between them.
  - **Hardware Virtualization** or **Platform Virtualization** refers to the creation of a virtual machine that acts like a real computer with an operating system. Software executed on these virtual machines is separated from the underlying hardware resources.

To understand these computer concepts, let's try to understand in terms of building a car, Honda City:

- Let's say Honda Japan has set up a manufacturing Unit in Greater Noida, India which is manufacturing Honda City Cars. To manufacture these cars Honda needs an assembly line (CPU) where workers would be assembling roughly 30,000 parts to make 1 car.
- It would not be possible to stock all 30,000 parts in shelf next to assembly line, because stocking all parts in shelves next to assembly line and finding any part out of these 30,000 parts would make the process very slow. So, around 16 parts immediately needed could be stocked in shelf (**Register**) next to assembly line.
- But after assembling the dash board, we want to assemble Steering wheel assembly for which a different set of components would be needed. These parts, which perhaps we would need for the rest of the day would be stocked in Assembly store (**Cache**) adjoining the assembly line, where some 512 parts can be stored so that they could be procured quickly.
- For the many parts which would be required over the next week, we have a Warehouse (**RAM**) some 8 km from the city; since land prices are cheap there and we deploy delivery vans (**Bus**) for transporting the parts to assembly line. This Warehouse is big and can hold some 30,000 different parts required for manufacturing Honda City.

- In the assembly line we are manufacturing Honda City but we are also planning to produce Honda Brio and also planning some model changes in City. So Honda has a worldwide warehouse (**Hard Disk**) in Tokyo where it stocks all the possible parts required by different models and versions and could be sent to any warehouse on request**.**
- Now, to assemble, a worker would have to follow various steps, referred as Machine Cycle (Fetch-Decode-Execute-Store) which gets executed within CPU and are given in Table 2.6.1:

**Fetch** → **Decode** → **Execute** → **Store**

**Table 2.6.1: Steps for a worker to assemble**

| | |
|---|---|
| A Worker prints an instruction sheet and gives to in-charge. | **(IF) fetch** an instruction from the currently running program, pass it to the next stage. |
| The in-charge gets a sheet. He reads and understands, picks two parts to be joined before the assembler (whose job is to assemble parts). | **(ID) instruction** would be decoded to figure out what we actually need to do and grab the two registers we're going to do math with. |
| The assembler would then take the two parts and join it. | **(EX) execution unit** will then perform some operation like an addition, multiplication or comparison on these two registers' contents. |
| If the joined pieces are not immediately needed a worker would transport them to assembly store or warehouse. | **(MEM) memory access** stage will handle storing or loading values between the registers and the RAM. |
| After completing the job, a worker will put the final result on the assembly shelf. | **(WB) Write Back** the result to another register so it's ready to go for the next operation. |

- These phases, **fetch** and **decode** are done by Control Unit (CU) whose job is to understand and explain to Arithmetic Logic Unit (ALU) whose job is to **execute** and results are **stored** in Register. This is machine cycle - the basis of computing.
- The Honda company car designers from headquarters in Japan issues instructions for manufacturing Honda City to the assembly Line workers in Greater Noida, but these designers have to know what instructions these workers are capable of following. These Instructions, which these workers are capable of following, are called **Instruction Sets**.

All instructions for manufacturing car have to ultimately be broken down to instructions the workers can understand. These instructions are given in Table 2.6.2.

- With the specific instruction, we can virtually do everything in a computer. Whatever we want a computer to do has to be broken down into above instruction which has to be explained in machine language to these hardworking workers (hardware).
- The above amply explains the computing process of our computer. Honda would be having some SOP (Standard Operating Procedures) manuals and all other manuals relating to workflow and design of assembly area. This could be considered to be Micro-architecture.

**Table 2.6.2: Instructions for Workers**

| Instruction | Meaning in Honda City Plant | In Computer's CPU |
|---|---|---|
| **Load** | If a part isn't currently on the shelf, get it from Assembly Store. | Load some data from the RAM into a register. |
| **Store** | If the shelf is full, we need to make space, so we should pick a piece that won't be needed immediately and store it in the Assembly store. | Free up a register by storing its data back into RAM. |
| **Add** | Attaching a part to another and then bringing it back to the shelf. | Add two pieces of data together. This could also be other common math operations like subtract, multiply, divide, shift, etc. |
| **Compare** | We need to check if a piece is going to fit before installing it, otherwise follow alternate instructions. | Check to see if one piece of data is bigger or smaller than another. |
| **Branch** | When we need to follow alternate instructions, either due to an incorrect piece as above, or because we need to repeat a certain step several times, we simply jump to the new location in the instructions and resume work from there. | Jump to a new location in the code and continue executing from there. |

### 2.6.3 Emerging Computing Models

This section provides brief overview of emerging computing technologies whose impact on enterprises will be felt increasingly in the near future. These emerging technologies are given as under:

**(I) Cloud Computing: Cloud Computing** is the use of various services, such as software development platforms, servers, storage, and software, over the Internet, often referred to as the "cloud."

### A. Cloud Computing Environment

The cloud computing environment can consist of multiple types of clouds based on their deployment and usage. These are depicted in the Fig. 2.6.1 and are explained as follows:

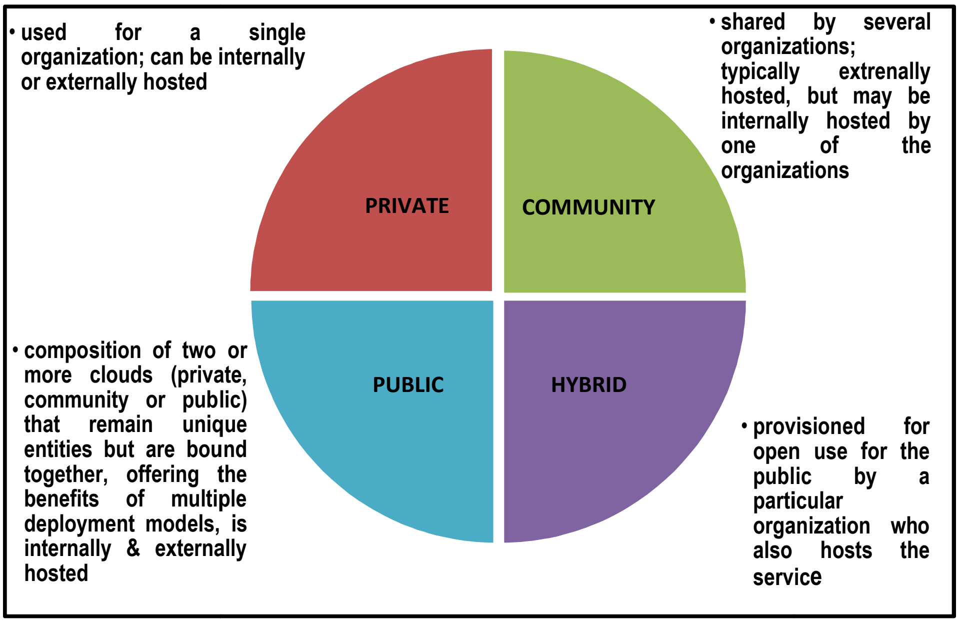



**Fig. 2.6.1: Cloud types and their relation**

- **Public Clouds:** The public cloud is made available to the general public or a large industry group. They are administrated by third parties or vendors over the Internet, and services are offered on pay-per-use basis. The key benefits are as follows:
  - (a) It is widely used in the development, deployment and management of enterprise applications, at affordable costs;
  - (b) It allows organizations to deliver highly scalable and reliable applications rapidly and at more affordable costs.
- **Private Clouds:** This cloud computing environment resides within the boundaries of an organization and is used exclusively for the organization's benefits. These are also called internal clouds. They are built primarily by IT departments within enterprises who seek to optimize utilization of infrastructure resources within the enterprise by provisioning the infrastructure with applications using the concepts of

grid and virtualization. The benefit of a Private Cloud is that it enables an enterprise to manage the infrastructure and have more control, but this comes at the cost of IT department creating a secure and scalable cloud.

- **Community Clouds:** This is the sharing of computing infrastructure in between organizations of the same community. For example, all Government organizations within India may share computing infrastructure on the cloud to manage data. The risk is that data may be stored with the data of competitors.
- **Hybrid Clouds:** It is maintained by both internal and external providers. It is a composition of two or more clouds (Private, Community or Public). They have to maintain their unique identity, but are bound together by standardized data and application portability. With a hybrid cloud, organizations might run non-core applications in a public cloud, while maintaining core applications and sensitive data in-house in a private cloud.

**B. Cloud Computing Architectural Considerations**

**Cloud Computing Architecture** refers to the components and subcomponents that typically consist of a front end platform (fat client, thin client, mobile device), back end platforms (servers, storage), a cloud based delivery, and a network (Internet, Intranet, Intercloud). Combined, these components make up cloud computing architecture. Cloud architecture typically involves multiple cloud components communicating with each other over a tight or loose coupling of cloud resources, services, middleware, and software components.

The protection in cloud computing depends on having the right architecture for the right application. Organizations must understand the individual requirements of their applications, and if already using a cloud platform, understand the corresponding cloud architecture.

A cloud computing architecture consists of two parts - **Front End** and a **Back End** that connect to each other through a network, usually the Internet. The front end is the side the computer user, or client, sees. The back end is the "cloud" section of the system.

- **Front End:** The **Front End** of the cloud computing system comprises of the client's devices (or it may be a computer network) and some applications are needed for accessing the cloud computing system. All the cloud computing systems do not give the same interface to users. For example-Web services like electronic mail programs use some existing web browsers such as Firefox, Microsoft's internet explorer or Apple's Safari. Other types of systems have some unique applications which provide network access to its clients.
- **Back End: Back End** refers to some physical peripherals. In cloud computing, the back end is cloud itself which may encompass various computer machines, data storage systems and servers. Groups of these clouds make a whole cloud

computing system. Theoretically, a cloud computing system can include practically any type of web application program such as video games to applications for data processing, software development and entertainment residing on its individual dedicated server for services. There are some set of rules, generally called as **Protocols** which are followed by this server and it uses a special type of software known termed as **Middleware** that allow computers that are connected on networks to communicate with each other. If any cloud computing service provider has many customers, then there's likely to be very high demand for huge storage space. Many companies that are service providers need hundreds of storage devices.

### C. Service Models of Cloud Computing

The service models are dynamically changing as cloud providers come out with new offerings focused on being competitive, increase market share, each with the aim to becoming one-stop shop. Mainly, there are five Cloud Computing Service based models. These are given as follows:

- **Infrastructure as a Service (IaaS):** It is the foundation of cloud services. It provides clients with access to server hardware, storage, bandwidth and other fundamental computing resources. The service is typically paid for on a usage basis. The service may also include dynamic scaling so that if the customer needs more resources than expected, s/he can get them on the fly (probably to a given limit). It provides access to shared resources on need basis, without revealing details like location and hardware to clients.
- **Software as a Service (SaaS):** It includes a complete software offering on the cloud. Users can access a software application hosted by the cloud vendor on pay-per-use basis. This is a well-established sector. SaaS is a model of software deployment where an application is hosted as a service provided to customers across the Internet by removing the need to install and run an application on a user's own computer. It is seen as a way for businesses to get the same benefits as commercial software with smaller cost outlay. SaaS can alleviate the burden of software maintenance and support but users relinquish control over software versions and requirements.
- **Platform as a Service (PaaS):** It provides clients with access to the basic operating software and optional services to develop and use software applications (e.g. database access and payment service) without the need to buy and manage the underlying computing infrastructure. For example, Google App Engine allows clients to run their web applications (i.e. software that can be accessed using a web browser such as Internet Explorer over the internet) on Google's infrastructure. It has evolved from Software as a Service (SaaS) and Infrastructure as a service (IaaS).The major drawback of Platform as a

Service is that it may lock us into the use of a particular development environment and stack of software components.

- **Network as a Service (NaaS):** It is a category of cloud services where the capability provided to the cloud service user is to use network/transport connecting services. NaaS involves optimization of resource allocation by considering network and computing resources as a whole. Some of the examples are: Virtual Private Network, Mobile Network Virtualization etc.
- **Communication as a Service (CaaS):** CaaS has evolved in the same lines as SaaS. CaaS is an outsourced enterprise communication solution that can be leased from a single vender. The CaaS vendor is responsible for all hardware and software management and offers guaranteed Quality of Service (QoS). It allows businesses to selectively deploy communication devices and modes on a pay-as-you-go, as-needed basis. This approach eliminates the large capital investments. Examples are: Voice over IP (VoIP), Instant Messaging (IM), Collaboration and Videoconferencing application using fixed and mobile devices.

Enterprises have to select the right service model based on their specific requirements. The selection has to be done considering various factors such as cost benefit analysis, relevant risks, security and controls and the criticality of the data and services. Typically, the enterprises would choose the model, which offers them the best savings with the required security.

*For further details, students are advised to refer to Chapter 5 "Business Process Automation through Application Software" of the Study Material of Intermediate (IPC) Course.*

**(II) Mobile Computing: Mobile Computing**, is the use of portable computing devices (such as laptop and handheld computers) in conjunction with mobile communications technologies to enable users to access the Internet and data on their home or work computers from anywhere in the world. It is a human–computer interaction by which a computer is expected to be transported during normal usage.

Mobile computing involves **Mobile Communication**, **Mobile Hardware** and **Mobile Software**; these are discussed as follows:

- **Mobile Communication:** Mobile Communication refers to the infrastructure put in place to ensure that seamless and reliable communication goes on. These would include devices such as Protocols, Services, Bandwidth and Portals necessary to facilitate and support the stated services. The data format is also defined at this stage. The signals are carried over the air to intended devices that are capable of receiving and sending similar kinds of signals. It will incorporate all aspects of wireless communication.

- **Mobile Hardware:** Mobile Hardware includes mobile devices or device components that receive or access the service of mobility. They would range from Portable laptops, Smart phones, Tablet PC's to Personal Digital Assistants. These devices will have receptors that are capable of sensing and receiving signals. These devices are configured to operate in full- duplex, whereby they are capable of sending and receiving signals at the same time.
- **Mobile Software:** Mobile Software is the actual program that runs on the mobile hardware. It deals with the characteristics and requirements of mobile applications. This is the engine of that mobile device. In other terms, it is the operating system of that appliance. It is the essential component that makes the mobile device operates.

Mobile computing is enabled by use of mobile devices (portable and hand held computing devices) such as PDA, laptops, mobile phones, MP3 players, digital cameras, tablet PC and Palmtops on a wireless network.

The constant and ever increasing demand for superior and robust smart devices has been a catalyst for Smart phones that are capable of performing the same tasks as computers and at the same processing speed. Apple's iPhone OS, Google's Android, Microsoft Windows Mobile and Research in Motion's Blackberry OS, are constantly competing to offer better products with each release.

### A. Business Applications of Mobile Computing

Mobile devices provide the capability to conduct business anywhere and enable users to seamless communicate and access information whether they are in the office or anywhere. Mobile computing is changing the business landscape. The change driven largely by video, web-browsing, gaming, and other entertainment related applications is one of the hottest trends in the consumer sector. Mobile computing is rapidly moving from gadget status to a must-have for consumers compelling more and more business services to be offered through this mode. As enterprises rush to encash the cost benefits of global business operations, mobile devices become increasingly indispensable.

Mobile computing enables enterprises to connect with their employees at all times resulting in increased productivity and a better return on investments. Some examples of business applications are:

- There is increase in workforce productivity as mobile device enables employees to work from anywhere, anytime by accessing and updating information as required. For example: employees can read/respond to emails using laptops, PDAs or smart phones from office, residence and even when on the move.
- Customer service can be improved by responding to customer queries on site or off site. For example: customer complaints can be accessed and responded by accessing past/latest information of client as required.

- Incident management can be improved by resolving problems faster without limitation of time as the concerned employees can attend to these regardless of their location. Further, escalations can be updated in real time which ensures timely resolution of problems. For example: Computer breakdowns can be serviced by service engineers from their desks/outside by logging into the specific computer, identify problem and resolve it online.
- Business processes can be transformed by using mobile devices. Enterprises can reengineer core business processes. The new and reengineered processes can focus on utilizing the key features of location and time independence. Enterprises can focus on providing customers and employees with access to information in different ways and provide the latest information. This enables employees, customers, and businesses to be available to one another as per their choice. For example: billing can be done by employees using hand held devices at customer site and the information updated online and deliveries to customers can be speeded up.
- Enterprises can dynamically modify and update their offerings and offer new products and services altogether. For example: enterprises can implement telecommuting with flexible working hours and locations allowing for cost savings and better efficiency.
- Mobile computing gives users the freedom to roam, with access to data and services at any time and in any place. Most of the high-end ERP and business software applications for SMEs have in-built capabilities of mobile computing enabling users to access data. Used with proper security, enterprises can harness the power of this technology to create innovative opportunities for improving the quality and efficiency of business processes and services. Mobile devices are increasingly acquiring the must-have status for enterprises on account of the increasing acceptance as business tools.

**B. Mobile Computing Concerns**

Major concerns relating to mobile computing are given as follows:

- Mobile computing has its fair share of security concerns as any other technology.
- Dangers of misrepresentation - Another problem plaguing mobile computing are credential verification.
- Power consumption: When a power outlet or portable generator is not available, mobile computers must rely entirely on battery power.
- Potential health hazards.

Being an ever growing and emerging technology, mobile computing will continue to be a core service in computing, Information Communication and Technology.

## 2.7 Information System Layers

Imagine that a Regional Sales Manager of an automobile manufacturing company wants to access sales figure relating to his/her region for the current quarter from the computerized information systems of the company. Let us try to visualize the processes involved:

- Regional Sales Manager makes a request for sales information in ERP system **(Application Program)**.
- Using a keyboard attached to his/her desktop **(Hardware)**.
- Keyboard accepts his request in English and Windows 7 **(Operating System - System Software)** converts that request to Bits or the ASCII, which the system understands based on which computing gets done.
- This request in form of Bits get converted to voltages travel on the cables, internet devices etc. to server at head office **(Networks)**.
- The server at head office will send the request to the ERP application end at the HO, which will then query the data through database such as Oracle **(Database Management Systems-DBMS)**.
- Get the data required and again through interactions among Operating System, Application Systems, networks, hardware and information will reach Regional Sales Manager **(User - People)**.

The above is of course a simplified version of process involved but gives a fair idea that any information system will have interaction amongst Application Software, DBMS, System Software, Hardware, Network links and People. These could be considered to be layers in Information system. These are pictorially represented in Fig. 2.7.1, which is given as follows:

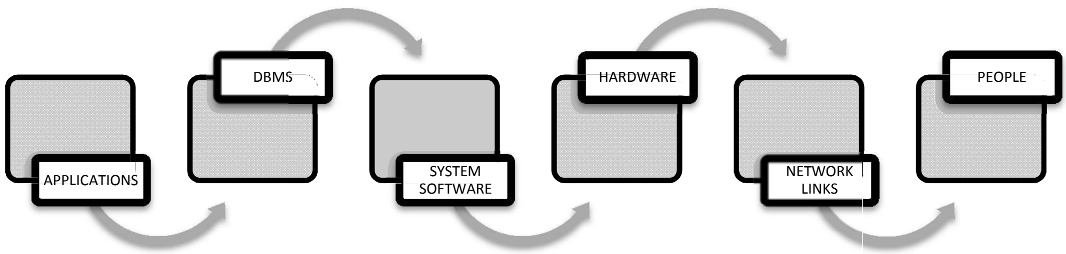



**Fig. 2.7.1: Layers in Information Systems**

Managers need to determine what types of hardware and software will satisfy their current and future business needs, the right time to buy the equipment, and how to protect their IT investments. This does not imply that managers need to be experts in all areas of technology; however, building a basic understanding of hardware and software can help them make the right IT investment choices. In the next section, we will take a look at the layers of IS in detail.

### 2.7.1 Application Software

Application software includes all those computer software that cause a computer to perform useful tasks beyond the running of the computer itself. It is a collection of programs which address a real life problem of its end users which may be business or scientific or any other problem.

The different types of application software are:

- **Application Suite:** Has multiple applications bundled together. Related functions, features and user interfaces interact with each other. E.g. MS Office 2010 which has MS Word, MS Excel, MS Access, etc.
- **Enterprise Software:** Addresses an enterprise's needs and data flow in a huge distributed environment. E.g. ERP Applications like SAP.
- **Enterprise Infrastructure Software:** Provides capabilities required to support enterprise software systems. E.g. email servers, Security software.
- **Information Worker Software:** Addresses individual needs required to manage and create information for individual projects within departments. E.g. Spreadsheets, CAAT (Computer Assisted Audit Tools)etc.
- **Content Access Software:** Used to access contents and addresses a desire for published digital content and entertainment. E.g. Media Players, Adobe Digital etc.
- **Educational Software:** Holds contents adopted for use by students. E.g. Examination Test CDs
- **Media Development Software:** Addresses individual needs to generate and print electronic media for others to consume. E.g. Desktop Publishing, Video Editing etc.

Some of the most popular and widely accepted benefits of Application Software are:

- **Addressing User needs:** Their single biggest advantage is that it meets the exact needs of the user. Since it is designed specifically with one purpose in mind, the user knows that he has to use the specific software to accomplish his task.
- **Less threat from virus:** The threat of viruses invading custom-made applications is very small, since any business that incorporates it can restrict access and can come up with means to protect their network as well.
- **Regular updates:** Licensed application software gets regular updates from the developer for security reasons. Additionally, the developer also regularly sends personnel to correct any problems that may arise from time to time.

There are certain disadvantages of such software as well and these are given as follows:

- **Development is costly:** Developing application software designed to meet specific purposes can prove to be quite costly for developers.

♦ **Infection from Malware:** If application software is used commonly by many people and shared online, it carries a highly real threat of infection by a computer virus or other malicious programs.

### 2.7.2 Hardware

Hardware is the tangible portion of our computer systems; something we can touch and see. It basically consists of devices that perform the functions of input, processing, data storage and output activities of the computer. Typical hardware architecture is shown in Fig. 2.7.2.

(i) **Input devices** are devices through which we interact with the systems and include devices like Keyboard, Mouse and other pointing devices, Scanners & Bar Code, MICR readers, Webcams, Microphone and Stylus/ Touch Screen. Keyboard helps us with text based input, Mouse helps us in position based input, Scanners & Webcams help in image based input and Microphone helps us in voice based input.

(ii) **Processing devices** include computer chips that contain the Central Processing Unit and main memory. The Central Processing Unit (CPU or microprocessor) is the actual hardware that interprets and executes the program (software) instructions and coordinates how all the other hardware devices work together. The CPU is built on a small flake of silicon and can contain the equivalent of several million transistors. We can think of transistors as switches which could be" on" or "off" i.e., taking a value of 1 or 0. The processor or CPU is like the brain of the computer. The main function of CPU is to execute programs stored in memory. It consists of three functional units:

- **Control Unit (CU):** CU controls the flow of data and instruction to and from memory, interprets the instruction and controls which tasks to execute and when.
- **Arithmetic and Logical Unit (ALU):** Performs arithmetic operations such as addition, subtraction, multiplication, and logical comparison of numbers: Equal to, Greater than, Less than, etc.
- **Registers:** These are high speed memory units within CPU for storing small amount of data (mostly 32 or 64 bits). Registers could be:
  - ➢ **Accumulators:** They can keep running totals of arithmetic values.
  - ➢ **Address Registers:** They can store memory addresses which tell the CPU as to where in the memory an instruction is located.
  - ➢ **Storage Registers:** They can temporarily store data that is being sent to or coming from the system memory.
  - ➢ **Miscellaneous:** These are used for several functions for general purpose.

(iii) **Data Storage Devices** refers to the memory where data and programs are stored. Various types of memory techniques/devices are given as follows:

**(a) Internal memory:** This includes Processer Registers and Cache Memory.

- **Processor Registers:** Registers are internal memory within CPU, which are very fast and very small.
- **Cache Memory:** There is a huge speed difference between Registers and Primary Memory (*discussed in lower section*). In order to bridge these speed differences, we have cache memory. Cache (pronounced as cash) is a smaller, faster memory, which stores copies of the data from the most frequently used main memory locations so that Processor/Registers can access it more rapidly than main memory. It is the property of locality of reference, which allows improving substantially the effective memory access time in a computer system.

**(b) Primary Memory/Main Memory:** These are devices in which any location can be accessed by the computer's processor in any order (in contrast with sequential order). These are primarily of two types:

- **Random Access Memory (RAM)**
  - ✓ Volatile in nature means Information is lost as soon as power is turned off.
  - ✓ This is Read Write memory.
  - ✓ Information can be read as well as modified.
- **Read Only Memory (ROM)**
  - ✓ This is non volatile in nature (contents remain even in absence of power).
  - ✓ Usually, these are used to store small amount of information for quick reference by CPU.
  - ✓ Information can be read not modified.
  - ✓ Generally used by manufacturers to store data & programs like translators that is used repeatedly.

**(c) Secondary Memory:** CPU refers to the main memory for execution of programs, but these main memories are volatile in nature and hence cannot be used to store data on a permanent basis in addition to being small in storage capacity. The secondary memories are available in bigger sizes, thus programs and data can be stored on secondary memories. Secondary storage differs from primary storage in that it is not directly accessible by the CPU. The computer usually uses its input/output channels to access secondary storage and transfers the desired data using intermediate area in primary storage. Secondary storage does not lose the data when the device is powered down: it is non-volatile. The features of secondary memory devices are non-volatility (contents are permanent in nature), greater capacity (they are available in large size), greater economy (the cost of these is lesser compared to register and RAMs) and slow speed (slower in speed compared to registers or primary storage). Storage devices could differ amongst each other in terms of speed and access time, cost/ portability, capacity and type of access. Based on these parameters most common forms of secondary storage are: USB Pen Drives, Floppy drive, Hard Drive, CD, DVD, Blue ray Disks and Smart cards.

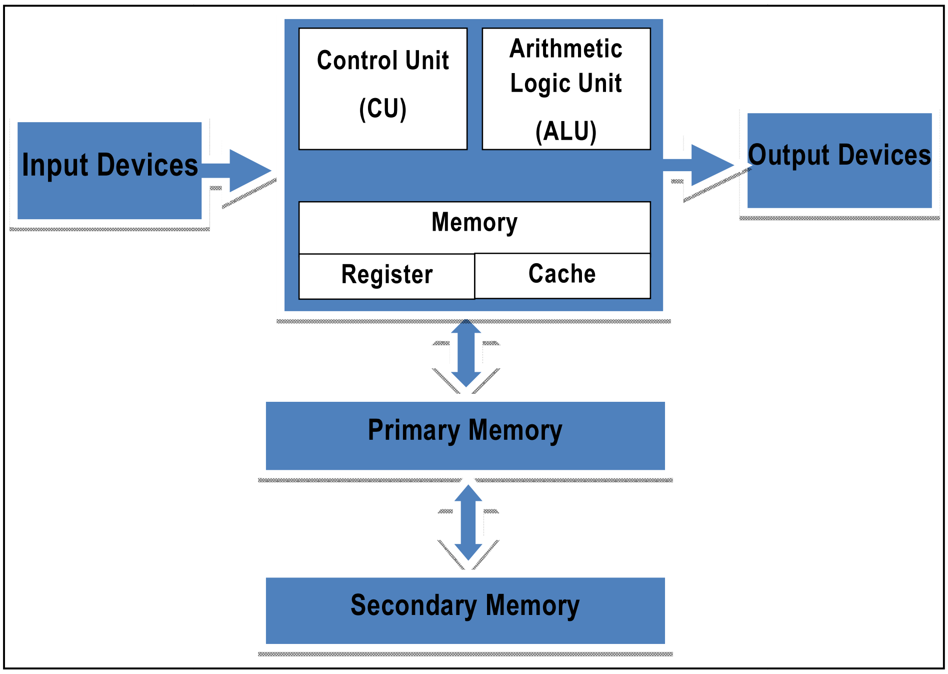



**Fig. 2.7.2: Hardware Architecture**

**(d) Virtual Memory:** Virtual Memory is in fact not a separate device but an imaginary memory area supported by some operating systems (for example, Windows) in conjunction with the hardware. If a computer lacks the Random Access Memory (RAM) needed to run a program or operation, Windows uses virtual memory to compensate. Virtual memory combines computer's RAM with temporary space on the hard disk. When RAM runs low, virtual memory moves data from RAM to a space called a paging file. Moving data to and from the paging file frees up RAM to complete its work. Thus, Virtual memory is an allocation of hard disk space to help RAM.

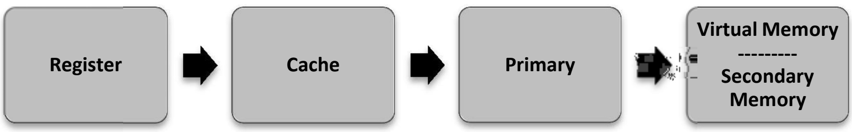



**Fig. 2.7.3: Memory Techniques/Devices**

A pictorial representation of all these aforementioned memory techniques/devices is given in Fig. 2.7.3:

(iv) **Output Devices:** Computers systems provide output to decision makers at all levels in an enterprise to solve business problems, the desired output may be in visual, audio or digital forms. Output devices are devices through which system responds. Visual output devices like, a display device visually conveys text, graphics, and video information. Information shown on a display device is called soft copy because the information exists electronically and is displayed for a temporary period of time. Various types of Output Devices are:

- **Cathode-Ray Tube (CRT):** A vacuum tube that uses an electron gun (cathode) to emit a beam of electrons that illuminates phosphors on a screen as the beam sweeps across the screen repeatedly. A monitor is often called a CRT.
- **Liquid Crystal Display (LCDs):** A low-powered display technology used in laptop computers where rod-shaped crystal molecules change their orientation when an electrical current flows through them.
- **Laser Printer:** A printer that forms images using an electrostatic process, the same way a photocopier works.
- **Ink-jet Printer:** A printer that makes images by forcing ink droplets through nozzles.
- **Plotter:** A printer that uses computer-directed pens for creating high-quality images, blueprints, schematics, etc.
- **Speakers:** Gives an audio output.

### 2.7.3 System Software

System software is computer software that is designed to operate the computer hardware and to give and maintain a platform for running application software. One of the most important and widely used system software is computer operating systems.

**An Operating System (OS)** is a set of computer programs that manages computer hardware resources and acts as an interface with computer applications programs. The operating system is a vital component of the system software in a computer system. Application programs usually require an operating system to function that provides a convenient environment to users for executing their programs. Computer hardware with operating system can thus be viewed as an extended machine, which is more powerful and easy to use. Some prominent Operating systems used nowadays are Windows 7, Windows 8, Linux, UNIX, etc.

A variety of activities are executed by Operating systems which include:

♦ **Performing hardware functions:** Application programs to perform tasks have to obtain input from keyboards, retrieve data from disk & display output on monitors. Achieving all this is facilitated by operating system. Operating system acts as an intermediary between the application program and the hardware.

- **User Interfaces***:* An important function of any operating system is to provide user interface. If we remember DOS days, it had a command based **User Interface (UI)** i.e. text commands were given to computer to execute any command. But today we are more used to **Graphic User Interface (GUI)** which uses icons & menus like in the case of Windows. So, how we interface with our system will be provided by Operating system.
- **Hardware Independence:** Every computer could have different specifications and configurations of hardware. If application developer would have to rewrite code for every configuration s/he would be in a big trouble. Fortunately, we have operating system, which provides **Application Program Interfaces (API)**, which can be used by application developers to create application software, thus obviating the need to understand the inner workings of OS and hardware. Thus, OS gives us hardware independence.
- **Memory Management:** Memory Management features of Operating System allow controlling how memory is accessed and maximize available memory & storage. Operating systems also provides Virtual Memory by carving an area of hard disk to supplement the functional memory capacity of RAM. In this way it augments memory by creating a virtual RAM.
- **Task Management:** Task Management feature of Operating system helps in allocating resources to make optimum utilization of resources. This facilitates a user to work with more than one application at a time i.e. multitasking and also allows more than one user to use the system i.e. timesharing.
- **Networking Capability:** Operating systems can provide systems with features & capabilities to help connect computer networks. Like Linux & Windows 8 give us an excellent capability to connect to internet.
- **Logical access security:** Operating systems provide logical security by establishing a procedure for identification & authentication using a User ID and Password. It can log the user access thereby providing security control.
- **File management:** The operating system keeps a track of where each file is stored and who can access it, based on which it provides the file retrieval.

### 2.7.4 Network Links

In today's high speed world, we cannot imagine an information system without an effective communication system. Effective and efficient communication is a valuable resource which helps in good management. To enable this communication, we need communication networks.

**Computer Network** is a collection of computers and other hardware interconnected by communication channels that allow sharing of resources and information. Where at least one process in one device is able to send/receive data to/from at least one process residing in a remote device, then the two devices are said to be in a network. A network is a group of devices connected to each other.

Each component, namely the computer in a computer network is called a '**Node**'. Computer networks are used for exchange of data among different computers and also to share the resources. Field of computer networks is one of the most interesting and rapidly growing fields in computer science. With man's desire for faster and better processing power, existing computer systems are connected to each other to form a computer network which allows them to share CPU, I/O devices, storages, etc. without much of an impact on individual systems.

In real world, we see numerous networks like Telephone/ mobile network, postal networks etc. If we look at these systems, we can analyze that networks could be of two types:

- **Connection Oriented networks:** Wherein a connection is first established and then data is exchanged like it happens in case of telephone networks.
- **Connectionless Networks:** Where no prior connection is made before data exchanges. Data which is being exchanged in fact has a complete contact information of recipient and at each intermediate destination, it is decided how to proceed further like it happens in case of postal networks.

These real world networks have helped model computer networks. Each of these networks is modeled to address the following basic issues:

- **Routing:** It refers to the process of deciding on how to communicate the data from source to destination in a network.
- **Bandwidth:** It refers to the amount of data which can be sent across a network in given time.
- **Resilience:** It refers to the ability of a network to recover from any kind of error like connection failure, loss of data etc.
- **Contention:** It refers to the situation that arises when there is a conflict for some common resource in a network. For example, network contention could arise when two or more computer systems try to communicate at the same time.

The following are the important benefits of a computer network:

- **Distributed nature of information:** There would be many situations where information has to be distributed geographically. E.g. in the case of Banking Company, accounting information of various customers could be distributed across various branches but to make Consolidated Balance Sheet at the year-end, it would need networking to access information from all its branches.
- **Resource Sharing:** Data could be stored at a central location and can be shared across different systems. Even resource sharing could be in terms of sharing peripherals like printers, which are normally shared by many systems. E.g. In the case of a CBS, Bank data is stored at a Central Data Centre and could be accessed by all branches as well as ATMs.
- **Computational Power:** The computational power of most of the applications would increase drastically if the processing is distributed amongst computer systems. For

example: processing in an ATM machine in a bank is distributed between ATM machine and the central Computer System in a Bank, thus reducing load on both.

- **Reliability:** Many critical applications should be available 24x7, if such applications are run across different systems which are distributed across network then the reliability of the application would be high. E.g. In a city there could be multiple ATM machines so that if one ATM fails, one could withdraw money from another ATM.
- **User communication:** Networks allow users to communicate using e-mail, newsgroups, video conferencing, etc.

### 2.7.5 Database Management Systems (DBMS)

Every enterprise needs to manage its information in an appropriate and desired manner. The enterprise has to do the following for this:

- Knowing its information needs;
- Acquiring that information;
- Organizing that information in a meaningful way;
- Assuring information quality; and
- Providing software tools so that users in the enterprise can access information they require.

To achieve the above objectives, we use Data Base Management System. Let's think of a DBMS as basically just a computerized record keeping. Database is just an electronic filing cabinet i.e., a collection of computerized data files. Even this simple system helps us do various operations on the files, such as:

- Adding new files to database,
- Deleting existing files from database,
- Inserting data in existing files,
- Modifying data in existing files,
- Deleting data in existing files, and
- Retrieving or querying data from existing files.

DBMS are software that aid in organizing, controlling and using the data needed by the application programme. They provide the facility to create and maintain a well-organized database. Applications access the DBMS, which then accesses the data. Commercially available Data Base Management Systems are Oracle, My SQL, SQL Servers and DB2 etc. Some other related aspects of DBMS are given as follows:

(i) **Data, Databases, Data Models:** The word Data is derived from Latin meaning "to give", thus Data is given facts from which additional facts can be inferred. Thus database is a collection of facts. Let's now look at the database model hierarchy. Hierarchy of database is as under:

- **Database**: This is a collection of Files.
- **File:** This is a collection of Records.
- **Record:** This is a collection of Fields.
- **Field:** This is a collection of Characters.
- **Characters:** These are a collection of Bits.

This hierarchy is shown in the Fig. 2.7.4:

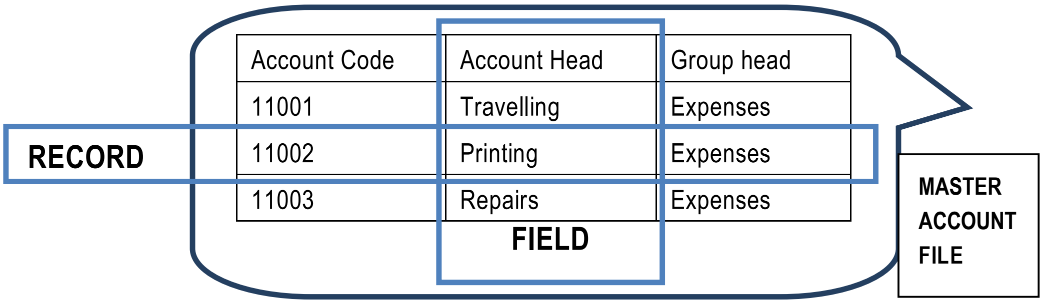



**Fig. 2.7.4: Hierarchy of Databases**

A database model is a type of data model that determines the logical structure of a database and fundamentally determines in which manner data can be stored, organized and manipulated. Some prominent database models are:

(i) Hierarchical Database Model,

(ii) Network Database Model,

(iii) Relational Database Model, and

(iv) Object Oriented Database Model

**A. Hierarchical Database Model:** In a hierarchical database model, records are logically organized into a hierarchy of relationships. A hierarchically structured database is arranged logically in an inverted tree pattern. For example, an equipment database, diagrammed in Fig. 2.7.5 may have building records, room records, equipment records, and repair records. The database structure reflects the fact that repairs are made to equipment located in rooms that are part of buildings.

All records in hierarchy are called nodes. Each node is related to the others in a parent-child relationship. Each parent record may have one or more child records, but no child record may have more than one parent record. Thus, the hierarchical data structure implements one-to-one and one-to-many relationships.

The top parent record in the hierarchy is called the **root record**. In this example, building records are the root to any sequence of room, equipment, and repair records. Entrance to this hierarchy by the database management system is made through the root record i.e., building.

Records that "own" other records are called **parent records.** For example, room records are the parents of equipment records. Room records are also children of the parent record, building. There can be many levels of node records in a database.

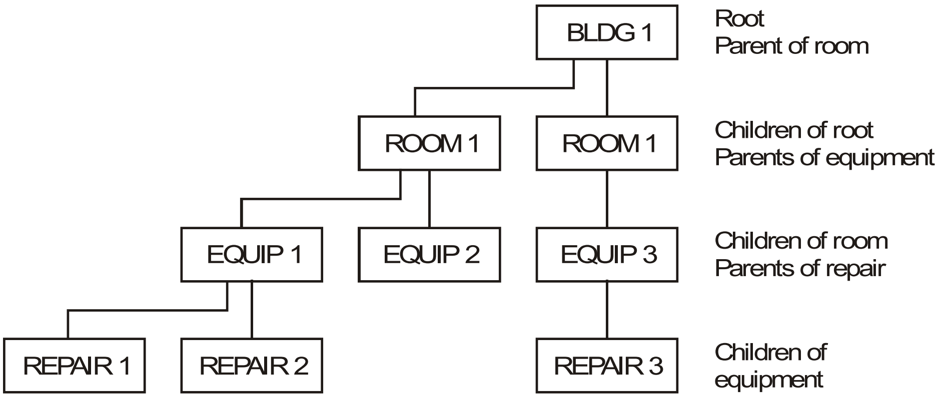



**Fig. 2.7.5: Hierarchical Database Model**

**B. Network Database Model:** The network model is a variation on the hierarchical model, to the extent that it is built on the concept of multiple branches (lower-level structures) emanating from one or more nodes (higher-level structures), while the model differs from the hierarchical model in that branches can be connected to multiple nodes. The network model is able to represent redundancy in data more efficiently than in the hierarchical model.

A network database structure views all records in sets. Each set is composed of an owner record and one or more member records. This is analogous to the hierarchy's parent-children relationship. Thus, the network model implements the one-to-one and the one-to-many record structures.

However, unlike the hierarchical mode, the network model also permits a record to be a member of more than one set at one time. The network model would permit the equipment records to be the children of both the room records and the vendor records. This feature allows the network model to implement the many-to-one and the many-to-many relationship types.

Network databases generally implement the set relationships by means of pointers that directly address the location of a record on disk. This gives excellent retrieval performance, at the expense of operations such as database loading and reorganization.

For example, suppose that in our database, it is decided to have the following records: repair vendor records for the companies that repair the equipment, equipment records for the various machines we have, and repair invoice records for the repair bills for the equipment. Suppose four repair vendors have completed repairs on equipment items 1,2,3,4,5,6,7 and 8. These records might be logically organized into the sets shown in Fig. 2.7.6.

Notice these relationships:

(i) Repair Vendor 1 record is the owner of the Repair Invoice 1 record. This is a one-to-one relationship.

(ii) Repair Vendor 2 record is the owner of the Repair Invoice 2 and 3 records. This is a one-to-many relationship.

(iii) Repair Vendor 3 record is the owner of Repair Invoice 4 and 5 records, and the Equipment 7 record owns both the Repair Invoice 5 and 6 records because it was fixed twice by different vendors. Because many equipment records can own many Repair Invoice records, these database records represent a many-to-many relationship.

(iv) Equipment 6 record does not own any records at this time because it is not required to be fixed yet.

(v) Equipment 7 and 8 own Repair Invoice 6 because the repairs to both machines were listed on the same invoice by Repair Vendor 4. This illustrates the many-to-one relationship.

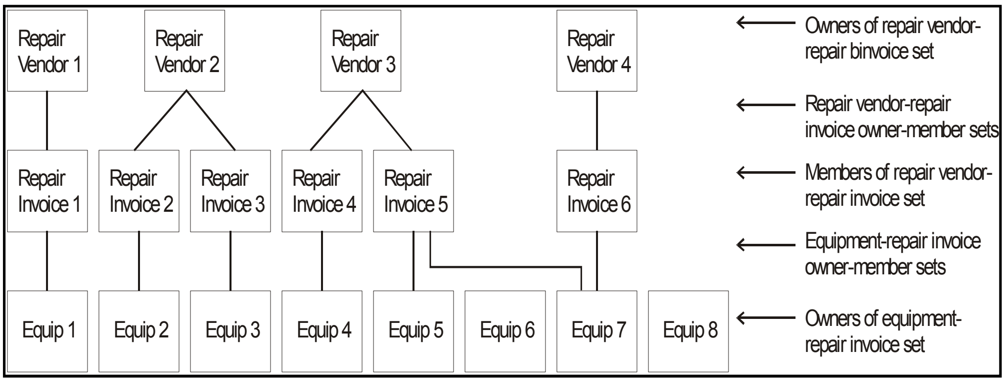



**Fig. 2.7.6: Example of Network Database Model**

Thus, all the repair records are members of more than one owner-member set: the repair vendor-repair invoice set and the equipment-repair invoice set. The network model allows us to represent one-to-one, one-to-many and many-to-many relationships. The network model also allows us to create owner records without member records. Thus, we can create and store a record about a new piece of equipment even though no repairs have been made on the equipment yet.

Unlike hierarchical data structures that require specific entrance points to find records in a hierarchy, network data structures can be entered and traversed more flexibly.

**C. Relational Database Model:** A third database structure is the relational database mode. Both the hierarchical and network data structures require explicit relationships, or links, between records in the database. Both structures also require that data be processed one record at a time. The relational database structure departs from both these requirements.

A relational database allows the definition of data and their structures, storage and retrieval operations and integrity constraints that can be organized in a table structure. A table is a collection of records and each record in a table contains the same fields.

Three key terms are used extensively in relational database models: **relations, attributes,** and **domains.** A relation is a table with columns and rows. The named columns of the relation are called attributes, and the domain is the set of values the attributes are allowed to take.

All relations (and, thus, tables) in a relational database have to adhere to some basic rules to qualify as relations. First, the ordering of columns is immaterial in a table. Second, there can't be identical record in a table. And third, each record will contain a single value for each of its attributes.

A relational database contains multiple tables, with at least similar value occurring in two different records (belonging to the same table or to different tables) that implies a relationship among those two records. The relationships between records in tables can also be defined explicitly, by identifying or non-identifying parent-child relationships characterized by assigning cardinality (1:1, 1:M, M:M). Tables can also have a designated single attribute or a set of attributes that can act as a "key", which can be used to uniquely identify each record in the table.

A key that can be used to uniquely identify a row in a table is called a primary key. Keys are commonly used to join or combine data from two or more tables. For example, an *Employee* table may contain a column named *Location* which contains a value that matches the key of a *Location* table. Keys are also critical in the creation of indexes, which facilitate fast retrieval of data from large tables. Any column can be a key, or multiple columns can be grouped together into a compound key.

**D. Object Oriented Data Base Model:** It is based on the concept that the world can be modeled in terms of objects and their interactions. Objects are entities conveying some meaning for us and possess certain attributes to characterize them and interacting with each other. An Object-oriented database provides a mechanism to store complex data such as images, audio and video, etc. An object oriented database (also referred to as object-oriented database management system or OODBMS) is a set of objects. In these databases, the data is modeled and created as objects.

An **Object-Oriented Database Management System (OODBMS)** helps programmers make objects created in a programming language behave as a database object. Object-oriented programming is based on a series of working objects. Each object is an independently functioning application or program, assigned with a specific task or role to perform. An object-oriented database management system is a relational database designed to manage all of these independent programs, using the data produced to quickly respond to requests for information by a larger application.

In the Fig. 2.7.7, the light rectangle indicates that 'engineer' is an object possessing attributes like 'date of birth', 'address', etc. which is interacting with another object known as 'civil jobs'.

When a civil job is commenced, it updates the 'current job' attribute of the object known as 'engineer', because 'civil job' sends a message to the latter object.

Objects can be organized by first identifying them as a member of a class / subclass. Different objects of a particular class should possess at least one common attribute. The dark rectangles indicate 'Engineer' as a class and 'Civil Engineer' and also 'Architect' as both subclasses of 'Engineer'. These subclasses possess all the attributes of 'Engineer' over and above each possessing at least one attribute not possessed by 'Engineer'. The line intersecting particular object classes represents the class of structure.

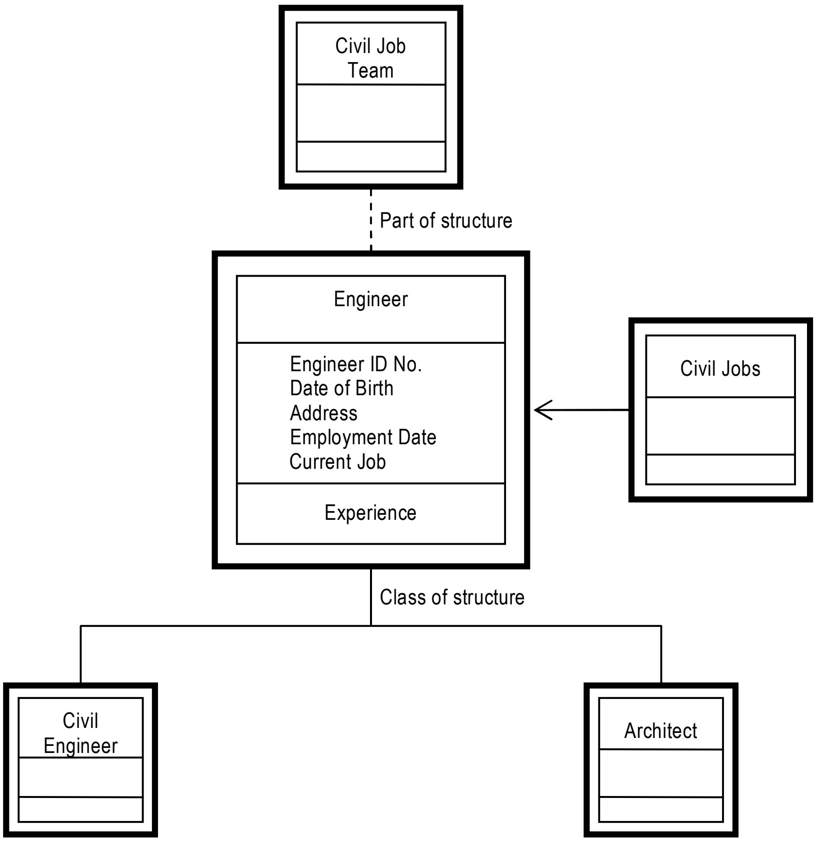



**Fig. 2.7.7: An object-oriented database design**

Secondly, objects can be identified as a component of some other object. 'Engineers' are components of a 'Civil Job Team' which may have one to more than one number of member(s). An 'Engineer' may not be a member of the 'Civil Job Team' and may not be a member of more than one team. The dotted line intersecting particular object classes represents the part of structure. Apart from possessing attributes, objects as well as possess methods or services that are responsible for changing their states.

In the Fig. 2.7.7 for example, the service 'Experience' as a Civil Engineer or Architect for the object 'Engineer' calculates how much experience the engineers of these particular two subclasses have as professionals.

### (ii) Advantages of a DBMS

Major advantages of DBMS are given as follows:

- **Permitting data sharing:** One of the principle advantages of a DBMS is that the same information can be made available to different users.
- **Minimizing Data Redundancy:** In a DBMS duplication of information or redundancy is, if not eliminated, carefully controlled or reduced i.e. there is no need to repeat the same data over and over again. Minimizing redundancy can therefore significantly reduce the cost of storing information on hard drives and other storage devices.
- **Integrity can be maintained:** Data integrity is maintained by having accurate, consistent, and up-to-date data. Updates and changes to the data only have to be made in one place in DBMS ensuring Integrity. The chances of making a mistake increase if the same data needs to be changed at several different places than making the change in one place.
- **Program and file consistency:** Using a DBMS, file formats and programs are standardized. This makes the data files easier to maintain because the same rules and guidelines apply across all types of data. The level of consistency across files and programs also makes it easier to manage data when multiple programmers are involved.
- **User-friendly:** DBMS makes the data access and manipulation easier for the user. DBMS also reduce the reliance of users on computer experts to meet their data needs.
- **Improved security:** DBMSs allow multiple users to access the same data resources which could lead to risk to an enterprise if not controlled. Security constraints can be defined i.e. Rules can be built to give access to sensitive data. Some sources of information should be protected or secured and only viewed by select individuals. Through the use of passwords, database management systems can be used to restrict data access to only those who should see it.
- **Achieving program/data independence:** In a DBMS data does not reside in applications but data bases program & data are independent of each other.
- **Faster application development:** In the case of deployment of DBMS, application development becomes fast. The data is already therein databases, application developer has to think of only the logic required to retrieve the data in the way a user needs.

### (iii) Disadvantages of a DBMS

There are basically two major downsides to using DBMSs. One of these is cost (both system and user training), and the other is the threat to data security. These are given as under:

- **Cost:** Implementing a DBMS system can be expensive and time-consuming, especially in large enterprises. Training requirements alone can be quite costly.
- **Security:** Even with safeguards in place, it may be possible for some unauthorized users to access the database. If one gets access to database then it could be an all or nothing proposition.

### 2.7.6 People/Users

People are the most important element in most computer-based information systems. The people involved include users of the system and information systems personnel, including all the people who manage, run, program, and maintain the system.

In the ever-changing world, innovation is the only key, which can sustain long-run growth. More and more firms are realizing the importance of innovation to gain competitive advantage. Accordingly, they are engaging themselves in various innovative activities. Understanding these layers of information system helps any enterprise grapple with the problems it is facing and innovate to perhaps reduce total cost of production, increase income avenues and increase efficiency of systems.

**Case Study**

Atul, a part of Lalbhai group, is a producer of agrochemicals, pharmaceuticals, aromatics, polymers, etc. Atul's accounts payable were largely built on a manual system. Whenever a shipment of goods arrived at Atul's factories, it was received by a store clerk who checked it for quality and quantity. The clerk then entered its details into Atul's computer system and generated a Goods Receipt Note (GRN). The invoices for the material accompanied with their GRNs were hand delivered to the accounts payable desk, whose staff then entered details into their system and created an accounts payable invoice. This new invoice was then sent to the company's CENVAT (Central Value Added Tax) reversal cell, whose job was to reclaim CENVAT. But many manual processes created a delay of up to 15 days between the time a store clerk received goods and the CENVAT team could reclaim CENVAT.

To tackle this problem, Atul integrated the accounts payable module of ERP with an automated invoice scanning system. The solution cleansed the accounts payable process of manual delays and mistakes in entry - ensuring that invoices are sent to the accounts payable team instantly and that Accounts Payable invoices are sent to the CENVAT team swiftly. The solution added ₹ 3 crores worth of CENVAT credits in Atul's books. First, the number of misplaced invoices or related documents shrunk to 0 from about 50 per month. The increased visibility ensured that payments to suppliers are made faster, shrinking late payment charges and increasing early payment bonuses. It also allowed for the faster identification of payable liabilities.

## 2.8 Information System Life Cycle

This is commonly referred as **Software/System Development Life Cycle (SDLC),** which is a methodology used to describe the process of building information systems. It is the logical starting point in the entire life cycle of a computerized system. Activities start when any enterprise decides to go for computerization or migrate from existing computerized system to a new one.

SDLC framework provides a sequence of activities for system designers and developers to follow. It consists of a set of steps or phases in which each phase of the SDLC uses the results of the previous one. This serves as a guideline to the designer, who seeks to use it as template while working on a project development.

An SDLC adheres to important phases that are essential for developers, such as Investigation, Analysis, design, implementation and maintenance and review; these are pictorially shown in Fig. 2.8.1. This includes evaluation of present system, information gathering; feasibility study and request approval.

In an organization, the current system may no longer be suitable for its purpose. Technological developments may have made the current system redundant or out-dated or the current system may be too inflexible or expensive to maintain. That is why the need for developing for new information system is generated. Various phases for developing an information system are given as follows:

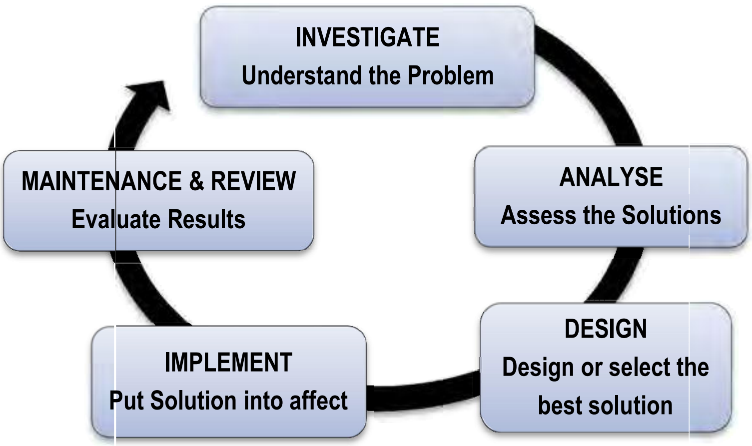



**Fig. 2.8.1: SDLC Phases**

### 2.8.1 Phase 1: System Investigation

This phase examines that 'What is the problem and is it worth solving'? We would be doing a feasibility study under the following dimensions:

- **Technical feasibility:** Does the technology exist to implement the proposed system or is it a practical proposition?

- **Economic feasibility:** Is proposed system cost-effective: if benefits do not outweigh costs, it's not worth going ahead?
- **Legal feasibility:** Is there any conflict between the proposed system and legal requirements?
- **Operational feasibility:** Are the current work practices and procedures adequate to support the new system?
- **Schedule feasibility:** How long will the system take to develop, or can it be done in a desired time-frame?

### 2.8.2 Phase 2: System Analysis

This phase examines that 'What must the Information System do to solve the problem'? System analyst would be gathering details about the current system and will involve:

- **Interviewing staff:** at different levels from end-users to senior management;
- **Examine current business:** systems documents and output including current order documents, computer system procedures and reports used by operations and senior management;
- **Sending out questionnaires:** that have to be carefully constructed to elicit unambiguous answers; and
- **Observation of current procedures:** by spending time in various departments. A time and motion study can show where procedures could be more efficient or to detect bottlenecks.

The Systems Analyst will:

- Examine data and information flows in the enterprise using data flow diagrams;
- Establish what the proposed system will actually do (not how it will do it);
- Analyze costs and benefits;
- Outline system implementation options. (e.g. in-house or using consultants);
- Consider possible hardware configurations; and
- Make recommendations.

### 2.8.3 Phase 3: System Designing

This phase examines that 'How will the Information System do that it must do to obtain the solution to the problem'? This phase specifies the technical aspects of a proposed system in terms of:

- **Hardware platform:** Computer, network capabilities, input, storage and output devices;
- **Software:** Programming language, package and database;
- **Outputs:** Report layouts and screen designs;
- **Inputs:** Documents, screen layouts and validation procedures;

- **User interface:** How users will interact with the computer system;
- **Modular design:** Of each program in the application;
- **Test plan:** Develop test data;
- **Conversion plan:** How the new system is to be implemented; and
- **Documentation:** Including systems and operations documentation. Later, a user manual will be produced.

### 2.8.4 Phase 4: System Implementation

This phase examines that 'How will the Solution be put into effect'? This phase involves the following steps:

- Coding and testing of the system;
- Acquisition of hardware and software; and
- Either installation of the new system or conversion of the old system to the new one.

In **Installation**, there are following major activities:

- Installing the new hardware, which may involve extensive re-cabling and changes in office layouts;
- Training the users on the new system; and
- Conversion of master files to the new system or creation of new master files.

In **Conversion**, there are following major activities:

- **Direct Changeover:** The user stops using the old system one particular day and starts using the new system from thereon, usually over a weekend or during a slack period.
- **Parallel Conversion:** The old system continues alongside the new system for a few weeks or months.
- **Phased Conversion:** Used with larger systems that can be broken down into individual modules which can be implemented separately at different times.
- **Pilot Conversion:** New system will first be used by only a portion of the enterprise, for example at one branch or factory.

### 2.8.5 Phase 5: System Maintenance and Review

This phase evaluates results of solution and modifies the system to meet the changing needs. Post implementation review would be done to address:

- Programming amendments,
- Adjustment of clerical procedures,
- Modification of Reports, and
- Request for new programs.

System maintenance could be with following different objectives:

- **Perfective Maintenance:** This implies that while the system runs satisfactorily, there is still room for improvement.
- **Adaptive Maintenance:** All systems will need to adapt to changing needs within a company.
- **Corrective Maintenance:** Problems frequently surface after a system has been in use for a short time, however thoroughly it was tested. Any errors must be corrected.

This is often the longest of the stages since it is an on-going process having some sort of long term continuum.

## 2.9 Recent Technologies/Devices

As we said earlier that technology is evolving in nature and accordingly, various new technologies, which effect enterprises, are given in the following sections.

### 2.9.1 Bluetooth

**Bluetooth** is a wireless technology standard for exchanging data over short distances up to 50 meters (164 feet) from fixed and mobile devices, creating Personal Area Networks (PANs) with high levels of security. It is a feature which is used every day through a number of compatible devices.

Bluetooth is really like a very low-power, short-range radio signal. Bluetooth signals are secure from the moment they're sent, so unlike any other wireless network we don't have to worry about turning on security. Few devices that utilize Bluetooth technology are as follows:

- Keyboards and mice,
- Printers,
- Cell phones and headsets,
- PDAs (Personal Digital Assistants),
- Desktop and laptop computers,
- Digital cameras, and
- Remotes: replacing IR (infrared).

Through the use of a mobile phone with Bluetooth enabled in them, we can send pictures, videos, exchange business cards and also transfer files to our PC. Both data and voice transmissions can be sent and received through the use of short range networks.

### 2.9.2 Wi-Fi

**Wi-Fi** is the name of a popular wireless networking technology that uses radio waves to provide wireless high-speed Internet and network connections. Wi-Fi networks have limited range. A typical wireless access point might have a range of 32 meters (120 ft.).

The Wi-Fi Alliance, the organization that owns the Wi-Fi (registered trademark) term specifically defines Wi-Fi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards. Wi-Fi can be less secure than wired connections because an intruder does not need a physical connection. Wi-Fi networks use radio technologies called 802.11 to provide secure, reliable, fast wireless connectivity. A Wi-Fi network can be used to connect electronic devices to each other, to the Internet, and to wired networks (which use Ethernet technology).

Large corporations and campuses use enterprise-level technology and Wi-Fi products to extend standard wired Ethernet networks to public areas like meeting rooms, training classrooms and large auditoriums. Many corporations also provide wireless networks to their off-site and telecommuting workers to use at home or in remote offices. Large companies and campuses often use Wi-Fi to connect buildings.

Wi-Fi networks also work well for small businesses, providing connectivity between mobile salespeople, floor staff and behind-the-scenes finance and accounting departments. Because small businesses are dynamic, the built-in flexibility of a Wi-Fi network makes it easy and affordable for them to change and grow.

### 2.9.3 Laptop: Notebook

**Laptop** is a small, portable computer and small enough that it can sit on a lap. The laptop was originally designed to be similar to a desktop, but be small and light enough that it could be used while sitting in our lap. Notebook is an extremely lightweight personal computer. Notebook computers typically weigh less than 3 Kg and are small enough to fit easily in a briefcase. Notebook computers use flat-panel technologies, to produce a lightweight and non-bulky display screen. If we consider computing power, modern notebook computers are almost equivalent to personal computers having the same CPUs, memory capacity and disk drives. These days due to reduction in size, weight the difference between Laptop and Notebook has become very thin and computer laptop is more frequently called a notebook computer. The difference between a laptop and notebook today is mainly what the manufacturer chooses to call its product.

### 2.9.4 Tablet Computer or Tablet

A **Tablet Computer** or simply tablet is a one piece general-purpose computer contained in a single panel. Its distinguishing characteristic is the use of a touch screen as the input device. Modern tablets are operated by fingers, and a stylus is an option, whereas earlier tablets required a stylus. Tablet PCs have become quite popular thanks to their extreme portability, easy to use interfaces and the wide range of ways they can be used. In many ways, they can almost replace a laptop for someone on the go.

Some features of Tablets are:

- **Input Method:** Tablets rely solely on a touch interface on the screen for all input.

- **Size:** This is probably the biggest reason to go with a tablet PC. Tablets have the size roughly of a small pad of paper and a weight that is less than one Kg.
- **Battery Life:** Tablets are design for efficiency because of the low power requirements of their hardware components. Tablets can achieve all day usage.
- **Storage Capacity:** Most tablets come with configurations that allow between 16 and 64 gigabytes of storage.
- **Performance:** Since most tablet PCs are based on extremely low powered processors more suited for tasks like email, web browsing, playing video or audio.
- **Software:** The two major tablet platforms are Android and iOS amongst plenty of applications that are available.
- **Wireless:** Because tablets by design are mobile computers; most of them have Wi-Fi, blue tooth and mobile connectivity.

### 2.9.5 SmartPhone

A **SmartPhone** is a mobile phone built on a mobile operating system, with more advanced computing capability connectivity than a feature phone. A smart phone could be considered to be the combination of the traditional PDA and cellular phone, with a bigger focus on the cellular phone part. These handheld devices integrate mobile phone capabilities with the more common features of a handheld computer or PDA. Smartphone's allow users to store information, e-mail and install programs, along with using a mobile phone in one device. A smart phone's features are usually more oriented towards mobile phone options than the PDA-like features. Modern smart phones also include high-resolution touch screens and web browsers that display standard web pages as well as mobile-optimized sites. High-speed data access is provided by Wi-Fi and mobile broadband.

### 2.9.6 Touchpad

A **Touchpad** is a pointing device featuring a tactile sensor, a specialized surface that can translate the motion and position of a user's fingers to a relative position on screen. Touchpads are a common feature of laptop computers, and are also used as a substitute for a mouse where desk space is scarce. Because they vary in size, they can also be found on Personal Digital Assistants (PDAs) and some portable media players. Wireless touchpads are also available as detached accessories.

Touchpads operate in one of several ways, including capacitive sensing and conductance sensing. The most common technology used entails sensing the capacitive virtual ground effect of a finger, or the capacitance between sensors. Capacitance-based touchpads will not sense the tip of a pencil or other similar implement. Gloved fingers may also be problematic.

While touchpads, like touch screens, are able to sense absolute position, resolution is limited by their size. For common use as a pointer device, the dragging motion of a finger is translated into a finer, relative motion of the cursor on the screen, analogous to the handling of a mouse that is lifted and put back on a surface. Hardware buttons equivalent to a standard mouse's left and right buttons are positioned below, above, or beside the touchpad.

### 2.9.7 iPad

The **iPad** runs a version of iOS. iOS is designed for finger based use and has none of the tiny features which required a stylus on earlier tablets. Apple introduced responsive multi touch gestures, like moving two fingers apart to zoom in. iOS uses less power, and so gives better battery life than the Intel devices used by Windows tablets.

### 2.9.8 iPod

The **iPod** is a line of portable media players designed and marketed by Apple Inc. The first line was released on October 23, 2001, about 8½ months after iTunes (Macintosh version) was released. Its most recent redesigns were announced on September 12, 2012. There are four current versions of the iPod: the ultra-compact iPod Shuffle, the compact iPod Nano, the touch screen iPod Touch, and the hard drive-based iPod Classic.

Like other digital music players, iPods can serve as external data storage devices. Storage capacity varies by model, ranging from 2 GB for the iPod Shuffle to 160 GB for the iPod Classic.

### 2.9.9 Ultra-Mobile PC (UMPC)

An **Ultra-Mobile PC** is a small form factor version of a pen computer, a class of laptop whose specifications were launched by Microsoft and Intel in spring 2006. UMPCs are smaller than subnotebooks, have a TFT display measuring (diagonally) about 12.7 to 17.8 cm (5 to 7 inch screen), are operated like tablet PCs using a touch screen or a stylus, and can also have a physical keyboard. There is no clear boundary between subnotebooks and ultra-mobile PCs.

The first-generation UMPCs were simple PCs running Linux or an adapted version of Microsoft's tablet PC operating system. With the announcement of the UMPC, Microsoft dropped the licensing requirement that tablet PCs must support proximity sensing of the stylus, which Microsoft termed "hovering".

### 2.9.10 Android

**Android** is a Linux-based operating system designed primarily for touch screen mobile devices such as smart phones and tablet computers. Android was built to enable developers to create compelling mobile applications that take full advantage of all a handset has to offer. Android powers devices from some of the best handset and tablet manufacturers in the world, like Samsung, HTC, Motorola, Sony, Asus and more. Android devices come in all shapes and sizes, with vibrant high-resolution displays and cameras, giving the flexibility to choose the one that's just right for a user.

Android is an open source and the permissive licensing allows the software to be freely modified and distributed by device manufacturers, wireless carriers and enthusiast developers.

Android provides access to a wide range of useful libraries and tools that can be used to build rich applications.

## 2.10 Summary

In this chapter, we learnt about IT as a key enabler in modern enterprises and the relevance of IT on auditing in terms of risks, security, control and changes required in audit process and procedures. We learnt how any enterprise to be effective and efficient has to use Business Process Automation (BPA), which is largely aided by Computers or IT. Information systems, which forms the backbone of any enterprise comprises of various layers such as: Application software, Database Management Systems (DBMS), System Software: Operating Systems, Hardware, Network Links and People-Users.

We have also understood that whenever an information system has to be deployed for the first time or some major changes are required, we need to implement information system life cycle. This has different phases, which encompass system development, system Investigation, system analysis, system design, system implementation and system Maintenance and review. This together are also referred to as the system development life cycle. We also learnt different terminologies relating to computing Technologies including popular computing technologies and emerging computing models such as Mobile Computing and some latest technologies like Bluetooth, Wi-Fi, Android, etc.

# 3

# Telecommunication and Networks

| Learning Objectives |
|---|
| ♦ To identify major developments and trends in the industries, technologies and business applications relating to telecommunications and Internet technologies; |
| ♦ To identify the basic components, functions, and types of telecommunications networks used in enterprises; |
| ♦ To explain the functions of major types of telecommunications network, hardware, software, media, and services; |
| ♦ To understand various topologies and architectures that a computer network might use; |
| ♦ To identify the risks involved in using a computer network and the control mechanisms to curb those risks; |
| ♦ To name specific types of wired and wireless transmission media and explain how they transmit data; |
| ♦ To understand some of the transmission protocols used in exchanging information over the network; and |
| ♦ To have an overview of e-Commerce and m-Commerce. |
| **Task Statements** |
| ♦ To review and evaluate developments and trends of telecommunication and Internet technologies; |
| ♦ To make use Internet, Intranet, and Extranet applications in businesses; |
| ♦ To identify the suitability of components, functions, and types of telecommunications networks; |
| ♦ To do the classification and application of various topologies and architectures of a computer network; |
| ♦ To secure communication over a network, to some extent; |
| ♦ To explain and name specific types of wired and wireless transmission media; and |
| ♦ To use e-Commerce and m-Commerce in various functions of an enterprise. |

**Knowledge Statements**

- To know the basic components, functions, and types of telecommunications networks used in business;
- To know the risks and related controls of a telecommunications network;
- To know various network topologies and applications;
- To know the specific types of wired and wireless transmission media; and
- To know various transmission protocols used to exchange information over the network.

## 3.1 Introduction

Organizations are becoming internetworked enterprises that use the Internet, intranets, and other telecommunications networks to support e-business operations and collaboration within the enterprise, and with their customers, suppliers, and other business partners. Telecommunications has entered a deregulated and fiercely competitive environment with many vendors, carriers, and services. Telecommunications technology is moving toward open, internetworked digital networks for voice, data, video, and multimedia. A major trend is the pervasive use of the Internet and its technologies to build interconnected enterprises and global networks, like intranets and extranets, to support enterprise collaboration, electronic commerce, and other e-business applications.

The explosive growth of the Internet and the use of its enabling technologies have revolutionized computing and telecommunications. The Internet has become the key platform for a rapidly expanding list of information and entertainment services and business applications, including enterprise collaboration and electronic commerce systems. Open systems with unrestricted connectivity using Internet technologies are the primary telecommunications technology drivers in e-business systems. Their primary goal is to promote easy and secure access by business professionals and consumers to the resources of the Internet, enterprise intranets, and inter-organizational extranets.

Companies are deriving strategic business value from the Internet, which enables them to disseminate information globally, communicate and trade interactively with customized information and services for individual customers, and foster collaboration of people and integration of business processes within the enterprise and with business partners. These capabilities allow them to generate cost savings from using Internet technologies, revenue increases from electronic commerce, and better customer service and relationships through interactive marketing and customer relationship management.

Businesses are installing and extending intranets throughout their organizations to improve communications and collaboration among individuals and teams within the enterprise; to publish and share valuable business information easily, inexpensively, and effectively via enterprise information portals and intranet websites and other intranet services; and to develop and deploy critical applications to support business operations and decision making.

The primary role of extranets is to link the intranet resources of a company to the intranets of its customers, suppliers, and other business partners. Extranets can also provide access to operational company databases and legacy systems to business partners. Thus, extranets provide significant business value by facilitating and strengthening the business relationships of a company with customers and suppliers, improving collaboration with its business partners, and enabling the development of new kinds of W eb-based services for its customers, suppliers, and others.

The major generic components of any telecommunications network are terminals, telecommunications processors, communication channels, computers, and telecommunications software. There are several basic types of telecommunications networks, including wide area networks (WANs) and local area networks (LANs). Most WANs and LANs are interconnected using client/server, network computing, peer-to-peer, and Internet networking technologies.

Telecommunications processors include modems, multiplexers, internetworked processors, and various devices to help interconnect and enhance the capacity and efficiency of telecommunications channels. Telecommunications networks use such media as twisted-pair wiring, coaxial cables, fiber-optic cables, terrestrial microwave, communications satellites, cellular and PCS systems, wireless LANs, and other wireless technologies. Telecommunications software, such as network operating systems and telecommunications monitors, controls and manages the communications activity in a telecommunications network.

## 3.2 Networking an Enterprise

In today's world, most businesses are expected to be networked enterprises to be able to sustain and grow. The Internet and Internet-like networks inside the enterprise are called **Intranets**, between an enterprise and its trading partners are called **Extranets**. These and other types of networks serve as the primary information technology infrastructure for many enterprises. Managers, teams, end users, and workgroups use telecommunications networks to electronically exchange data and information anywhere in the world with other end users, customers, suppliers, and business partners. By using such networks, companies can perform more effectively as they can:

- Collaborate more creatively;
- Manage their business operations and organizational resources more effectively; and
- Compete successfully in today's fast changing global economy.

Now-a-days, survival of many organizations is not feasible without a variety of interconnected computer networks to service their various information processing and communications needs.

## 3.3 Trends in Telecommunication

Major trends are occurring in the field of telecommunications and these have a significant impact on management decisions. Therefore, it is necessary for managers, end users and other stakeholders to be aware of major trends in telecommunications industries, technologies, and applications that significantly increase the decision alternatives confronting their organizations. A pictorial representation of major telecommunications trend is shown in the Fig. 3.3.1.

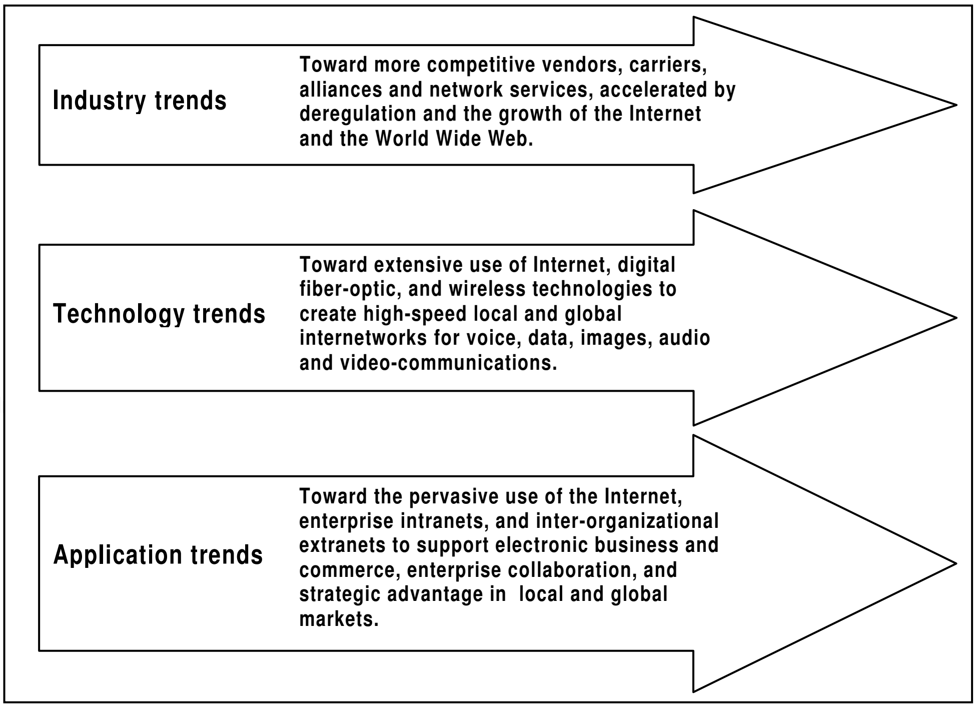



**Fig. 3.3.1: Trends in Telecommunication**[*]

Let us discuss these aforementioned trends in detail.

### 3.3.1 Industry Trends

Some of the major industry trends are:

- Telecommunications networks and services are available from numerous large and small telecommunications companies.
- Explosive growth of the Internet and the World Wide Web has created a host of new telecommunications products, services and providers.
- Business firms have dramatically increased their use of the Internet and the Web for electronic commerce and collaboration.

[*] “Introduction to Information Systems” by James O’Brien, George M. Marakas, 11th edition, McGraw Hill, Page 221

### 3.3.2 Technology Trends

Now-a-days, technology is moving towards:

- Open systems with unrestricted connectivity, using Internet networking technologies as their technology platform, are becoming the primary telecommunications technology drivers.
- Increased industry and technical moves towards building client/server networks based on open system architecture. Open systems are information systems that use common standards for hardware, software, applications, and networking. Any open system provides greater connectivity, that is, the ability of network computers and other devices to easily access and communicate with each other and share information. Open systems architecture also provides a high degree of network interoperability. That is, open systems enable many different applications of end users to be accomplished using the different varieties of computer systems, software packages, and databases provided by a variety of interconnected networks.
- Change from analog to digital network technologies. Local and global telecommunications networks are rapidly converting to digital transmission technologies that transmit information in the form of discrete pulses, rather than waves. Digital transmission offers higher transmission speeds (transmits with pulses),movement of greater amounts of information, greater economy, much lower error rates than analog systems, and telecommunications networks to carry multiple types of communications (data, voice, and video) on the same circuits. (Integrated Services Digital Network (ISDN) technology)
- Change in communications media. Many telecommunications networks are changing from copper wire-based media and land-based microwave relay systems to fiber-optic lines and communications satellite transmissions. Fiber-optic transmission, which uses pulses of a laser-generated light, offer significant advantages in terms of:
  - Reduced size and installation effort
  - Greater communication capacity,
  - Faster transmission speeds, and
  - Freedom from electrical interference.

### 3.3.3 Business Application Trends

Some of the today's application trends are:

- The trend toward more vendors, services, Internet technologies, and open systems, and the rapid growth of the Internet, the World Wide Web, and corporate intranets and extranets, dramatically increases the number of feasible telecommunications applications.

- Telecommunications networks are playing a v ital and pervasive role in electronic commerce, enterprise collaboration, and internal business applications that support the operations, management, and strategic objectives of both large and small companies.
- Telecommunications functions have become an integral part of local and global computer networks that are used to dramatically:
    - Lock in customers and suppliers,
    - Shorten business lead times and response times,
    - Support electronic commerce,
    - Improve the collaboration of workgroups,
    - Develop new products and services,
    - Share resources,
    - Cut costs, and
    - Develop online operational processes.

## 3.4 The Business Value of Telecommunications

Information technology, especially in telecommunications-based business applications, helps company overcome barriers to business success. The widely used information systems in enterprises are highly facilitated through telecommunication systems that help in increase in productivity and performance of an o rganization. The strategic capabilities of telecommunications and other information technologies include:

- **Overcome geographic barriers:** capture information about business transactions from remote locations.
- **Overcome time barriers:** Provide information to remote locations immediately after it is requested.
- **Overcome cost barriers:** Reduce the cost of more traditional means of communication.
- **Overcome structural barriers:** Support linkages for competitive advantage.

Organizations, therefore, in a telecommunication network can improve communication, reduce costs, improve efficiency, reduce errors and improve consistency under the light of the aforementioned capabilities of computer network.

## 3.5 Telecommunications Network

Telecommunications is a highly technical, rapidly changing field of information systems technology. Most end users do not need a detailed knowledge of its technical characteristics. However, they need a basic understanding and appreciation for some of the important characteristics of the basic components of telecommunications networks.

### 3.5.1 Need and Scope of Networks

As the business grows, good communication between employees is needed. The organizations can improve efficiency by sharing information such as common files, databases and business application software over a telecommunication network. With improvements in network capacity and the ability to work wirelessly or remotely, successful businesses should regularly re-evaluate their needs and their IT infrastructure. Here are some of the advantages of a computer network in an organization:

(i) **File Sharing** - It provides sharing and grouping of data files over the network.

(ii) **Resource Sharing** - It provides sharing of c omputer resources such as hard disk, printers etc. by multiple users simultaneously to reduce the cost of installing and maintaining multiple resources in the organization.

(iii) **Remote Access** - Network allows users to remotely access the data and information from organization's network via Internet in cost effective manner.

(iv) **Shared Databases** -Network facilitates simultaneous access to the shared databases to multiple users at the same time by ensuring the integrity of the database.

(v) **Fault Tolerance** - By using network, fault tolerance can be implemented as a defense against accidental data loss. Usually, primary and secondary line of defense backups the data in case of system failure. Additional measures can also be taken by attaching a server with un-interruptible power supply in case of power failure or blackouts.

(vi) **Internet Access and Security** - It provides access to the Internet for transferring the document and to access the resources available on World Wide Web by maintaining data security through firewall system in the organization's network.

### 3.5.2 Telecommunication Network Model

Generally, a communication network is any arrangement where a sender transmits a message to a receiver over a channel consisting of some type of medium.

Fig. 3.5.1 illustrates a simple conceptual model of a telecommunications network, which shows that it consists of five basic categories of components: **Terminals, Telecommunications Processors, Telecommunications Media/Channels, Computers and Telecommunications Control Software.**

**A. Terminals:** Terminals are the starting and stopping points in any telecommunication network environment. Any input or output device that is used to transmit or receive data can be classified as a te rminal component. These include Video Terminals, Microcomputers, Telephones, Office Equipment, Telephone and Transaction Terminals.

**B. Telecommunications Processors:** Telecommunications Processors support data transmission and reception between terminals and computers by providing a variety of control and support functions. They include Network Interface Card, Modem, Multiplexer and Internetworked Processors.

- **Network Interface Card (NIC):** Network Interface Card (NIC) is a computer hardware component that connects a computer to a computer network. It has additional memory for buffering incoming and outgoing data packets, thus improving the network throughput.
- **Modems:** A MODEM is a device that converts a digital computer signal into an analog telephone signal (i.e. it modulates the signal) and converts an analog telephone signal into a digital computer signal (i.e. it demodulates the signal) in a data communication system. The word "modem" is a contraction of modulate and demodulate. Modems are required to send computer data with ordinary telephone lines because computer data is in digital form but telephone lines are analog.
- **Multiplexers:** A multiplexer is a communications processor that allows a single communications channel to carry simultaneous data transmissions from many terminals. Typically, a multiplexer merges the transmissions of several terminals at one end of a communications channel, while a similar unit separates the individual transmissions at the receiving end.
- **Internetwork Processors:** Telecommunications networks are interconnected by special-purpose communications processors called internetwork processors such as switches, routers, hubs, bridges, repeaters and gateways.
    - **Switch** - Switch is a communications processor that makes connections between telecommunications circuits in a network so that a telecommunications message can reach its intended destination.
    - **Router –** Router is a communications processor that interconnects networks based on different rules or *protocols*, so that a telecommunications message can be routed to its destination.
    - **Hub –** Hub is a port-switching communications processor. This allows for the sharing of the network resources such as servers, LAN workstations, printers, etc.
    - **Bridge –** Bridge is a communications processor that connects numerous Local Area Networks (LANs). It magnifies the data transmission signal while passing data from one LAN to another.
    - **Repeater –** Repeater is a communications processor that boosts or amplifies the signal before passing it to the next section of cable in a network.
    - **Gateway –** Gateway is a communications processor that connects networks that use different communication architectures.

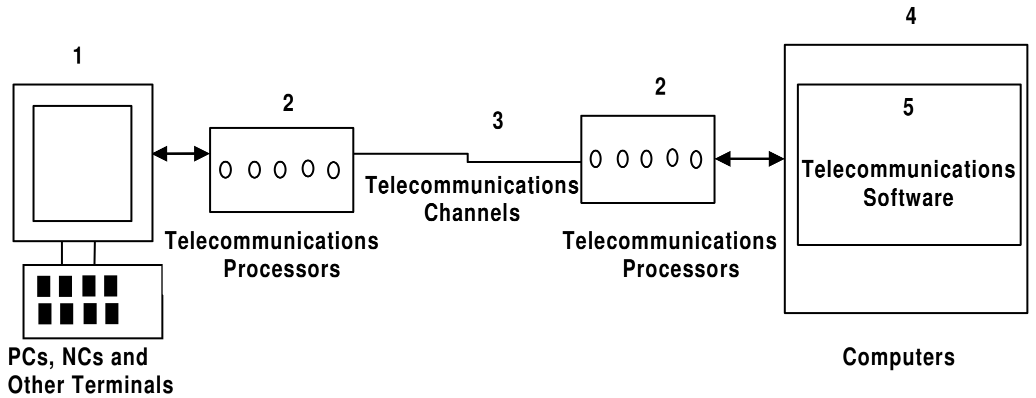



**Fig. 3.5.1: Telecommunications Network Model***

**C. Telecommunications Media/Channels:** Telecommunications channels are the part of a telecommunications network that connects the message source with the message receiver. Data are transmitted and received over channels, which use a variety of telecommunications media. Telecommunications media are grouped into **Guided Media** and **Unguided Media**.

- **Guided Media/Bound Media: Guided Transmission Media** uses a "cabling" system that guides the data signals along a specific path. The data signals are bound by the "cabling" system. Some of the common examples of guided media are Twisted Pair, Coaxial cable and Fiber optics.

  - **Twisted-Pair Wire: Twisted-pair** is ordinary telephone wire, consisting of copper wire twisted into pairs as shown in the Fig. 3.5.2. It is the most widely used media for telecommunications and is used for both voice and data transmissions. It is used extensively in home and office telephone systems and many LANs and WANs. However, there are few disadvantages of the same. Twisted Pair Wire is susceptible to various types of electrical interference (noise), which limits the practical distances that data can be transmitted without being garbled. Signals must be "refreshed" every one to two miles through the use of repeaters, which are very expensive and does not offer security.

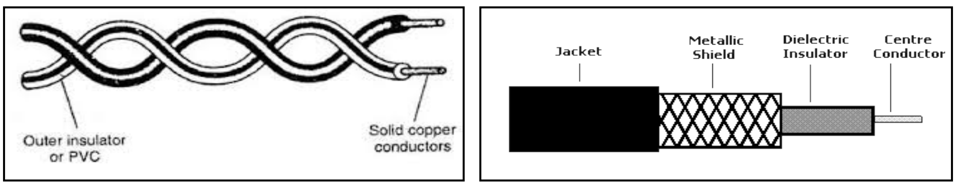



**Fig. 3.5.2: Twisted Pair and Coaxial Cable respectively**

* "Introduction to Information Systems" by James O'Brien, George M. Marakas, 11th edition, McGraw Hill, Page No. 238

- **Coaxial Cable:** This telecommunications media consists of copper or aluminum wire wrapped with spacers to insulate and protect it (as shown in the Fig. 3.5.2). Insulation minimizes interference and distortion of the signals the cable carries. Coaxial cables can carry a large volume of data and allows high-speed data transmission used in high-service metropolitan areas for cable TV systems, and for short-distance connection of computers and peripheral devices. These cables can be bundled together into a m uch larger cable for ease of installation and can be placed underground and laid on the floors of lakes and oceans. It is used extensively in office buildings and other work sites for local area networks. The only disadvantage of coaxial cable is that it is more expensive than twisted pair.
- **Fiber Optics:** This media consists of one or more hair-thin filaments of glass fiber wrapped in a protective jacket as shown in the Fig. 3.5.3. Signals are converted to light form and fired by laser in bursts. Optical fibers can carry digital as well as analog signals and provides increased speed and greater carrying capacity than coaxial cable and twisted-pair lines. It is not affected by electromagnetic radiation and not susceptible to electronic noise and so it has much lower error rates than twisted-pair and coaxial cable. Fiber optic cables are easy to install since they are smaller and more flexible and can be used undersea for transatlantic use. Speed of communications is 10,000 times faster than that of microwave and satellite systems.

  Biggest disadvantages of using fiber optic cable are that installation can be difficult and costly to purchase.

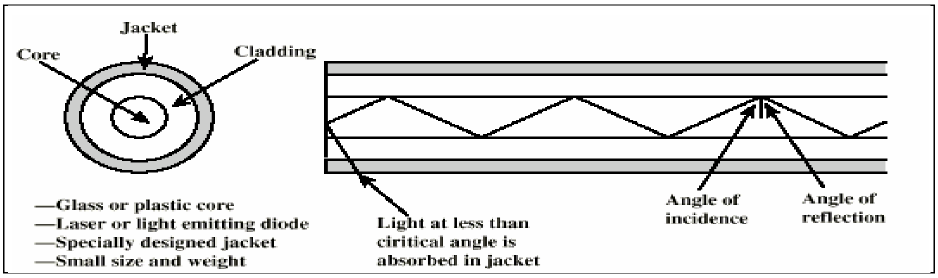



**Fig. 3.5.3: Optical Fiber**

♦ **Unguided Media/Unbound Media:** Unguided Transmission Media consists of a means for the data signals to travel but nothing to guide them along a specific path. The data signals are not bound to a cabling media. Some of the common examples of unguided media are **Terrestrial Microwave, Radio waves, Micro Waves**, **Infrared Waves** and **Communications Satellites**.

- **Terrestrial Microwave: Terrestrial microwave** involves earthbound microwave systems, which transmit high-speed radio signals in a line-of-sight path between relay stations spaced approximately 30 m iles apart. Terrestrial microwave media uses the atmosphere as the medium through which to transmit signals, and is used extensively for high-volume as well as long-distance communication of both data and voice in the form of electromagnetic waves. However major disadvantage of terrestrial microwave is that it cannot bend around the curvature of the earth.

- **Radio Waves:** Wireless networks do not require any physical media or cables for data transmission. **Radio waves** are an invisible form of electromagnetic radiation that varies in wavelength from around a millimeter to 100,000 km, making it one of the widest ranges in the electromagnetic spectrum. Radio waves are most commonly used transmission media in the wireless Local Area Networks.
- **Micro Waves: Microwaves** are radio waves with wavelengths ranging from as long as one meter to as short as one millimeter, or equivalently, with frequencies between 300 MHz (0.3 GHz) and 300 GHz. These are used for communication, radar systems, radio astronomy, navigation and spectroscopy.
- **Infrared Waves: Infrared light** is used in industrial, scientific, and medical applications. Night-vision devices using infrared illumination allow people or animals to be observed without the observer being detected. Infrared tracking, also known as infrared homing, refers to a passive missile guidance system which uses the emission from a target of electromagnetic radiation in the infrared part of the spectrum to track it.
- **Communication Satellites: Communication satellites** use the atmosphere (microwave radio waves) as the medium through which to transmit signals. A satellite is some solar-powered electronic device that receives, amplifies, and retransmits signals; the satellite acts as a relay station between satellite transmissions stations on the ground (earth stations). They are used extensively for high-volume as well as long-distance communication of both data and voice. It is cost-effective method for moving large quantities of data over long distances. However, satellites are very expensive to develop and place in orbit and have an age limit of 7-10 years. Signals weaken over long distances; weather conditions and solar activity can also cause noise interference. Anyone can listen in on satellite signals, so sensitive data must be sent in a secret, or encrypted, form.

**D. Computers:** In a telecommunications networks, **computers** of all sizes and types are connected through media to perform their communication assignments. They include Host Computers (mainframes), Front-End Processors (minicomputers) and Network Servers (microcomputers).

**E. Telecommunications Control Software:** This consists of programs that control telecommunications activities and manage the functions of telecommunications networks. They include Telecommunication Monitors (mainframe host computers), Network Operating Systems (microcomputer network servers) for network servers, Network Management Components and Communication Packages (Microcomputer Web browsers). This software can reside on almost any component of the network and can provide such features as performance monitoring, activity monitoring, priority assigning, transmission error correction and network problem mitigation.

♦ **Network Management:** Telecommunications software packages provide a variety of communication support services. For example, they work with a communications processor to connect and disconnect communications links and establish communications parameters such as transmission speed, mode, and direction. Examples of major network management functions include:

- **Traffic management**– manages network resources and traffic to avoid congestion and optimize telecommunications service levels to users.
- **Security**– provides authentication, encryption, and auditing functions, and enforces security policies.
- **Network monitoring**– troubleshoot and watch over the network, informing network administrators of potential problems before they occur.
- **Capacity planning**– surveys network resources and traffic patterns and users' needs to determine how best to accommodate the needs of the network as it grows and changes.

*Note: Detail of Network Management Function is provided in the later section (3.9: Network Administration and Management) of the Chapter.*

## 3.6 Classification of Telecommunication Networks

There are many different types of telecommunications networks which can be classified on the basis of different factors like: **Area Coverage Based, Functional Based and Ownership-based** etc. as briefed in the Table 3.6.1.

**Table 3.6.1: Computer Networks Classification**

| 1 | Class I | Area Coverage Based Classification |
|---|---|---|
| | **LAN** | A Local Area Network (LAN) is a group of computers and network devices connected together, usually within the same building, campus or spanned over limited distance. It provides high speed data transfer and is relatively inexpensive. |
| | **MAN** | A Metropolitan Area Network (MAN) is a larger network that usually spans in the same city or town. Cable network is an example of a MAN. |
| | **WAN** | A Wide Area Network (WAN) is not restricted to a geographical location, although it might be confined within the bounds of a state or country. The technology is high speed and relatively expensive. The Internet is an example of a world-wide public WAN. |
| **2** | **Class II** | **Functional Based Classification** |
| | **Client-Server** | This partitions tasks or workloads between the providers of a resource or service, called servers, and service requesters, called clients. |

| | | |
|---|---|---|
| | **Peer-to-Peer** | It is a type of decentralized and distributed network architecture in which individual nodes in the network (called "peers") act as both suppliers and consumers of resources |
| | **Multi-Tier** | It provides a model by which developers can create flexible and re-usable applications. |
| **3** | **Class III** | **Ownership-based Classification** |
| | **Public Network** | Network established for all users across the world is known as public network. Internet is an example of public network. |
| | **Private Network** | Private Network is used by particular organization, particular campus or particular enterprise only. This is a network that is not available to the outside world. Intranet is an example of it. |
| | **Virtual Private Network (VPN)** | A Virtual Private Network (VPN) is a network that uses a public network, such as the Internet, to provide secure access to organization's private network. A key feature of a VPN is its ability to work over both private networks as well as public networks like the Internet. Using a method called tunneling, a VPN uses the same hardware infrastructure as existing Internet or Intranet links. |

A detailed discussion on the aforementioned networks is as follows:

### 3.6.1 Area Coverage Based Classification

**A. Local Area Network:** The **Local Area Networks (LAN)** are telecommunications networks that connect information-processing devices within a limited physical area. These networks cover areas such as Offices, Classrooms, Buildings, Manufacturing plant etc. Some of the characteristics of LANs include the following:

- LANs use a variety of telecommunications media, such as ordinary telephone wiring, coaxial cable, or wireless radio systems to interconnect microcomputer workstations and computer peripherals.
- To communicate over the network, a PC usually has a circuit board called a network interface card.
- Most LANs use a powerful microcomputer with a large disk capacity as a file server or network server that contains a network operating system (e.g., Novell NetWare) that controls telecommunications and the use of network resources.
- LANs allow end users in a workgroup to communicate electronically; share hardware, software, and data resources; and pool their efforts when working on group projects.

LANs on a distributed environment allow having our own independent processing stations while sharing expensive computer resources like disk files, printers and plotters. Further LAN provides:

(i) **Security** - Security for programs and data can be achieved using servers that are locked through both software and by physical means. Diskless nodes also offer security by not allowing users to download important data on floppies/CDs or upload unwanted software or virus.

(ii) **Expanded PC usage through inexpensive workstation -** Once a LAN has been set up, it actually costs less to automate additional employees through diskless PCs. Existing PCs can be easily converted into nodes by adding network interface cards.

(iii) **Distributed processing -** Many organizations operate as if they had distributed system in place. If numerous PCs are installed around the office, these machines represent the basic platform for a LAN with inter-user communication and information exchange.

(iv) **Electronic mail and Message Broadcasting -** Electronic mail allows users to communicate more easily among them. Messages to other users can be dropped into the recipient's mail-box and read by them when they log into the network.

(v) **Organizational Benefits -** LANs provide numerous benefits that include reduced costs in computer hardware, software and peripherals, and a drastic reduction in the time and cost of training or re-training manpower to use the systems.

(vi) **Data management benefits -** Since data is located centrally on the server, it becomes much easier to manage it, access it, as well as back it up.

(vii) **Software cost and up-gradation -** If the organization is concerned about using licensed software purchasing, a network version can save a lot of money since there would be no need to buy multiple copies of the same software for every machine in the organization. Therefore, software upgrades are much easier as any given package is stored centrally on the server.

**B. Metropolitan Area Network (MAN):** A **Metropolitan Area Network (MAN)** is somewhere between a LAN and a WAN. The term MAN is sometimes used to refer to networks which connect systems or local area networks within a metropolitan area (roughly 40 km in length from one point to another). A MAN interconnects computer resources in a geographic area or region larger than that covered by a large LAN but smaller than the area covered by a WAN.

A MAN can support both data and voice. Cable television networks are examples of MANs that distribute television signals. A MAN just has one or two cables and does not contain switching elements.

**C.** **Wide Area Network (WAN): Wide Area Networks** are telecommunications networks that cover large geographic areas with various communication facilities such as long distance telephone service, satellite transmission, and under-sea cables. These networks cover areas such as:

- Large city or metropolitan area
- Whole country
- Many countries and continents

Examples of WANs are interstate banking networks and airline reservation systems.

### 3.6.2 Functional Based Classification

**A. Client-Server Networking**

**Client/Server (C/S) Networks: Client/server networks** have become predominate information architecture of enterprise computing. Computing power has rapidly become distributed and interconnected throughout many organizations by networked computer systems that take the form of client/server networks. The Client/Server computing is an environment that satisfies the business need buy appropriate allocating the application processing between the client and the server processors.

Client/Server network is a computer network in which one centralized powerful computer (called Server) is connected to many less powerful PCs or workstations (called Clients). The clients run programs and access data that are stored on the server. Example – WWW/E-Mail.

- **Client:** A client is a single-user workstation that provides a presentation services and the appropriate computing, connectivity and the database services relevant to the business need. Client computers can be classified as **Fat Client, Thin Client or Hybrid Client**.
  - **Fat / Thick Client:** A **fat client** or **thick client** is a client that performs the bulk of any data processing operations itself, and does not necessarily rely on the server. Unlike thin clients, thick clients do not rely on a central processing server because the processing is done locally on the user system, and the server is accessed primarily for storage purposes. For that reason, thick clients often are not well-suited for public environments. To maintain a thick client, IT needs to maintain all systems for software deployment and upgrades, rather than just maintaining the applications on the server. For example – Personal Computer.
  - **Thin Client: Thin clients** use the resources of the host computer. A thin client generally only presents processed data provided by an application server, which performs the bulk of any required data processing. A thin client machine is going to communicate with a central processing server, meaning there is

little hardware and software installed on the user's machine. A device using web application (such as Office Web Apps) is a thin client.

- **Hybrid Client:** A **Hybrid Client** is a mixture of the above two client models. Similar to a fat client, it processes locally, but relies on the server for storing persistent data. This approach offers features from both the fat client (multimedia support, high performance) and the thin client (high manageability, flexibility). Hybrid clients are well suited for video gaming.

- **Server:** A **server** is one or more multi-user processors with shared memory providing computing, connectivity and the database services and the interfaces relevant to the business need.

**Working of a Client/Server Network:** A typical Client/Server architecture has been shown in the Fig. 3.6.1.

- Servers are typically powerful computers running advanced network operating systems. Servers can host e-mail; store common data files and serve powerful network applications such as Microsoft's SQL Server. As a centerpiece of the network, the server validates login to the network and can deny access to both networking resources as well as client software.
- End user Personal Computer or Network Computer workstations are the Clients.
- Clients are interconnected by local area networks and share application processing with network servers, which also manage the networks. Client and Server can operate on separate computer platforms.
- Either the client platform or the server platform can be upgraded without having to upgrade the other platform.
- The server is able to service multiple clients concurrently; in some client/server systems, clients can access multiple servers.
- Action is usually initiated at the client end, not the server end.
- The network system implemented within the client/server technology is commonly called by the computer industry as **Middleware**. Middleware is all the distributed software needed to allow clients and servers to interact. General Middleware allows for communication, directory services, queuing, distributed file sharing, and printing.

A typical Client/Server architecture looks like Fig. 3.6.1.

Some of the prominent characteristics of C/S architecture are as follows:

- **Service:** C/S provides a clean separation of function based on the idea of service. The server process is a provider of services and the client is a consumer of services.

- **Shared Resources:** A server can service many clients at the same time and regulate their access to the shared resources.
- **Transparency of Location:** C/S software usually masks the location of the server from the clients by redirecting the service calls when needed.
- **Mix-and-Match:** The ideal C/S software is independent of hardware or Operating System software platforms.
- **Scalability:** In a C/S environment, client workstations can either be added or removed and also the server load can be distributed across multiple servers.
- **Integrity:** The server code and server data is centrally managed, which results in cheaper maintenance and the guarding of shared data integrity. At the same time, the clients remain personal and independent.

**Issues in Client/Server Network**

(i) When the server goes down or crashes, all the computers connected to it become unavailable to use.

(ii) Simultaneous access to data and services by the user takes little more time for server to process the task.

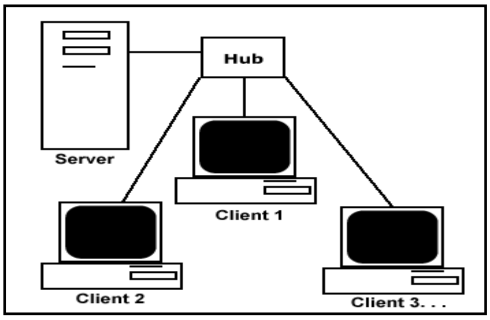



**Fig. 3.6.1: Client/Server Components**

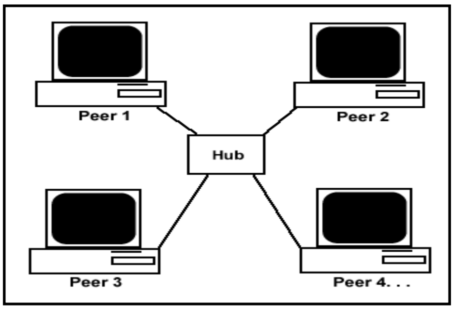



**Fig. 3.6.2: Peer-to-Peer Architecture**

**B. Peer-to-Peer Networking (P2P)**

**Peer-to-Peer Network:** A **Peer-to-Peer (P2P) network** is created with two or more PCs connected together and share resources without going through a separate server computer. A P2P network can be an ad hoc connection - a couple of computers connected via a universal serial bus to transfer files. A P2P network also can be a permanent infrastructure that links half-dozen computers in a small office over copper wires. Example – Napster, Freenet etc. Refer to the Fig. 3.6.2.

The prime objective goal of a P2P (Peer-to-Peer) file-sharing network is that many computers come together and pool their resources to form a content distribution system. The computers are often simply home computers. They do not need to be machines in

Internet data centers. The computers are called peers because each one can alternately act as a client to another peer, fetching its content, and as a server, providing content to other peers. Though there is no dedicated infrastructure, P2P networks handle a very high volume of file sharing traffic by distributing the load across many computers on the Internet. Everyone participates in the task of distributing content, and there is often no central point of control.

Configured computers in P2P workgroups allow sharing of files, printers and other resources across all of the devices. Peer networks allow data to be shared easily in both directions, whether for downloads to the computer or uploads from the computer. Because they do not rely exclusively on central servers, P2P networks both scale better and are more resilient than client-server networks in case of failures or traffic bottlenecks. A P2P network can be a network on a much grander scale in which special protocols and applications set up direct relationships among users over the Internet.

**Advantages**

Following are the major advantages of Peer-to-Peer networks:

(i) Peer-to-Peer Networks are easy and simple to set up and only require a Hub or a Switch to connect all the computers together.

(ii) It is very simple and cost effective.

(iii) If one computer fails to work, all other computers connected to it continue to work.

**Disadvantages**

The major disadvantages of peer-to-peer networks are as below:

(i) There can be problem in accessing files if computers are not connected properly.

(ii) It does not support connections with too many computers as the performance gets degraded in case of high network size.

(iii) The data security is very poor in this architecture.

### C. Multi-Tier Architecture

A tier is a distinct part of hardware or software.

#### a. Single Tier Systems/ One-Tier Architecture

A single computer that contains a database and a front-end (GUI) to access the database is known as Single Tier System. Generally, this type of system is used in small businesses. Fig. 3.6.3 shows single tier architecture.

One-tier architecture involves putting all of the required components for a software application or technology on a single server or platform. This kind of architecture is often contrasted with multi-tiered architecture or the three-tier architecture that's used for some

Web applications and other technologies where various presentation, business and data access layers are housed separately. There is one computer which stores all of the company's data on a single database. The interface used to interact with the database may be part of the database or another program which ties into the database itself.

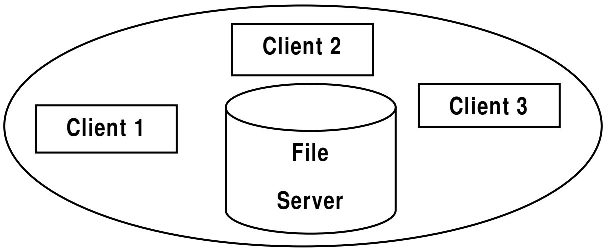



**Fig. 3.6.3: Single Tier Architecture**

**Advantages:** A single-tier system requires only one stand-alone computer. It also requires only one installation of proprietary software which makes it the most cost-effective system available.

**Disadvantages:** It can be used by only one user at a time. A single tier system is impractical for an organization which requires two or more users to interact with the organizational data stores at the same time.

**b. Two Tier Systems/ Two Tier Architecture**

A two-tier system consists of a client and a server. A two-tier architecture is a software architecture in which a presentation layer or interface runs on a client, and a data layer or data structure gets stored on a server. In other words, the database is stored on the server, and the interface used to access the database is installed on the client.

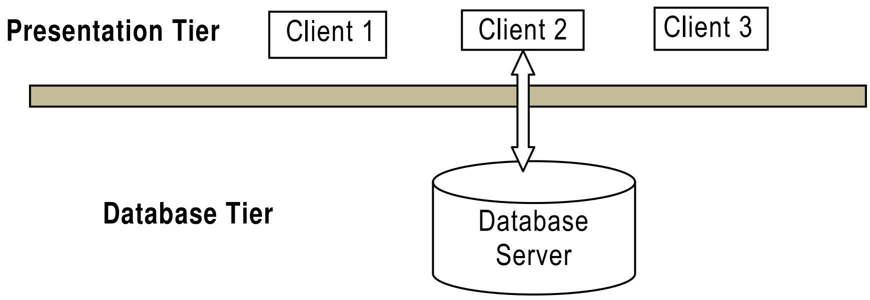



**Fig. 3.6.4: Two Tier Architecture**

Separating these two components into different locations represents two-tier architecture, as opposed to single-tier architecture. Other kinds of multi-tier architectures add additional layers in distributed software design. The user system interface is usually located in the user's desktop environment and the database management services are usually in a server that is more powerful machine that services many clients. Refer Fig. 3.6.4.

The advantages of Two-Tier systems are as follows:

- The system performance is higher because business logic and database are physically close.
- Since processing is shared between the client and server, more users could interact with system.
- By having simple structure, it is easy to setup and maintain entire system smoothly.

The disadvantages of Two-Tier systems are as follows:

- Performance deteriorates if number of users increases.
- There is restricted flexibility and choice of DBMS, since data language used in server is proprietary to each vendor.

### c. n-Tier Architecture

**n-Tier Architecture** is a client–server architecture in which presentation, application processing, and data management functions are logically separated. By segregating an application into tiers, developers acquire the option of modifying or adding a specific layer, instead of reworking the entire application. For example, an application that uses middleware to service data requests between a user and a database employs multi-tier architecture. The most widespread use of multi-tier architecture is the Three-tier architecture.

#### Three Tier Architecture

Three-tier architecture is a client-server architecture in which the functional process logic, data access, computer data storage and user interface are developed and maintained as independent modules on separate platforms. Three-tier architecture is a software design pattern and well-established software architecture. Its three tiers are the presentation tier, application tier and data tier. The three tier architecture is used when an effective distributed client/server design is needed that provides (when compared to the two-tier) increased performance, flexibility, maintainability, reusability and scalability, while holding the complexity of distributed processing from the user.

As shown in the Fig. 3.6.5, the three tiers in three-tier architecture are as follows:

i. **Presentation Tier:** Occupies the top level and displays information related to services available on a website. This tier communicates with other tiers by sending results to the browser and other tiers in the network.

ii. **Application Tier:** Also called the middle tier, logic tier, business logic or logic tier, this tier is pulled from the presentation tier. It controls application functionality by performing detailed processing.

iii. **Database Tier:** This tier houses the database servers where information is stored and retrieved. Data in this tier is kept independent of application servers or business logic.

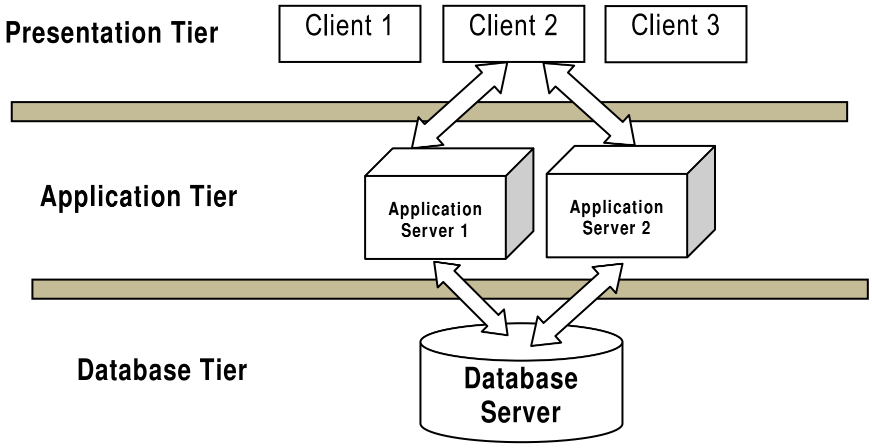



**Fig. 3.6.5: Three-Tier Architecture**

The following are the advantages of Three-Tier systems:

- **Clear separation of user-interface-control and data presentation from application-logic:** Through this separation more clients are able to have access to a wide variety of server applications. The two main advantages for client-applications are quicker development through the reuse of pre-built business-logic components and a shorter test phase.
- **Dynamic load balancing:** If bottlenecks in terms of performance occur, the server process can be moved to other servers at runtime.
- **Change management:** It is easy and faster to exchange a component on the server than to furnish numerous PCs with new program versions.

The disadvantages of Three-Tier systems are as below:

- It creates an increased need for network traffic management, server load balancing, and fault tolerance.
- Current tools are relatively immature and are more complex.
- Maintenance tools are currently inadequate for maintaining server libraries. This is a potential obstacle for simplifying maintenance and promoting code reuse throughout the organization.

### 3.6.3 Ownership Based Classification

**A. Public Data Network:** A **Public Data Network** is defined as a network shared and accessed by users not belonging to a single organization. It is a network established and operated by a telecommunications administration, or a recognized private operating agency, for the specific purpose of providing data transmission services for the public. The Internet is an example of a Public Data Network.

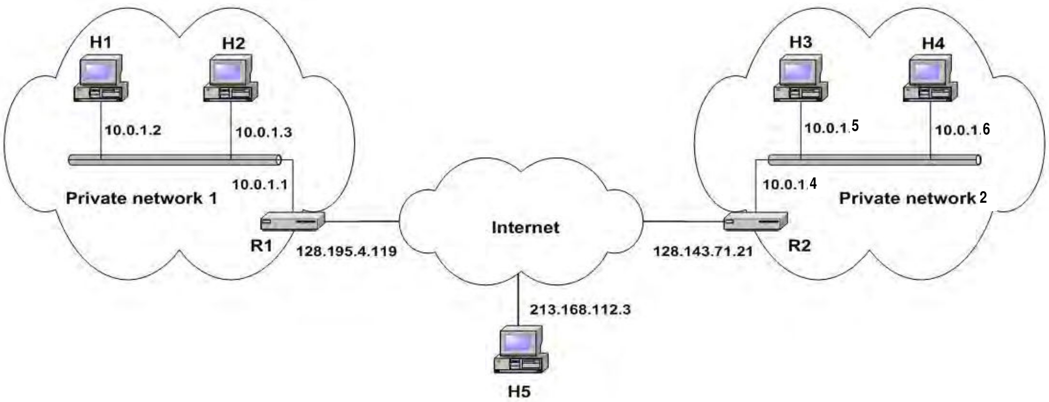



**Fig. 3.6.6: Public vs. Private Network**

**B. Private Data Network: Private Data Networks** provide businesses, government agencies and organizations of all sizes as a dedicated network to continuously receive and transmit data critical to both the daily operations and mission critical needs of an organization.

Fig. 3.6.6 displays the difference between Private and Public Data Networks.

**C. Virtual Private Networks (VPN):** Many companies have offices and plants scattered over many cities, sometimes over multiple countries. In the olden days, before public data networks, it was common for such companies to lease lines from the telephone company between some or all pairs of locations. Private networks work fine and are very secure. If the only lines available are the leased lines, no traffic can leak out of company locations and intruders have to physically wiretap the lines to break in, which is not easy to do. The problem with private networks is that leasing a dedicated line between two is too expensive.

This demand soon led to the innovation of **VPN**s (**Virtual Private Networks**), which are overlay networks on top of public networks but with most of the properties of private networks. They are called ‘‘virtual’’ because they are merely an illusion, just as virtual.

Many organizations use Virtual Private Networks (VPNs) to establish secure intranets and extranets. A VPN is a private network that uses a public network (usually the Internet) to connect remote sites or users together. The VPN uses "virtual” connections routed through the Internet from the business's private network to the remote site or employee. By using a VPN, businesses ensure security - anyone intercepting the encrypted data can't read it.

VPN is a secure network that uses the Internet as its main backbone network, but relies on the firewalls and other security features of the Internet and Intranet connections and those of participating organizations.

## 3.7 Network Computing

The growing reliance on the computer hardware, software, and data resources of the Internet, Intranets, extranets, and other networks has emphasized that for many users "the network is the computer". Fig. 3.7.1 depicts network computing model. This network computing, or network-centric, concept views networks as the central computing resource of any computing environment. Features of network computing include the following:

- In Network Computing, network computers and other thin clients provide a browser-based user interface for processing small application programs called applets. Thin clients include network computers, Net PCs, and other low-cost network devices or information appliances.

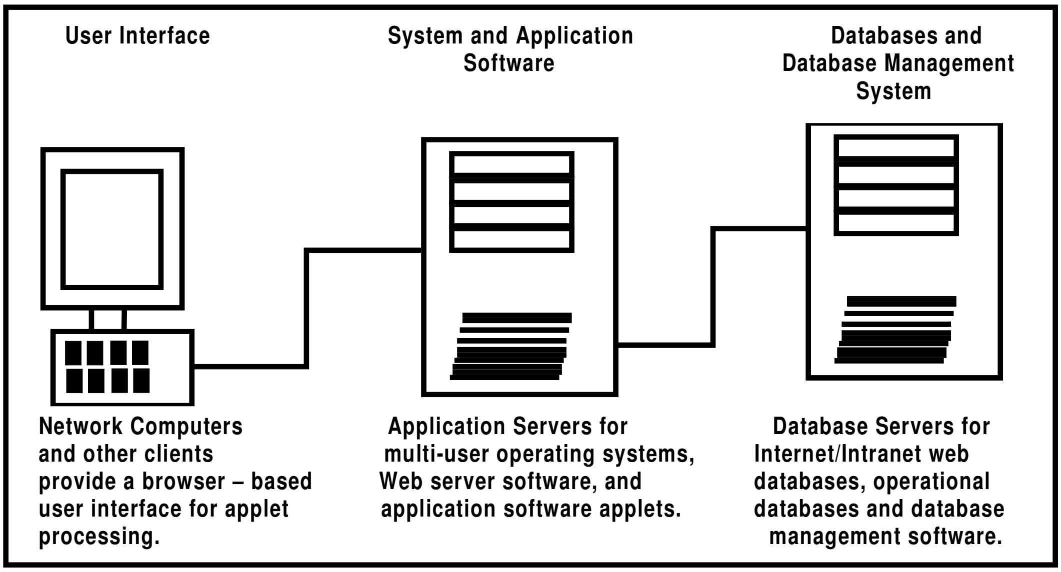



**Fig. 3.7.1: Network Computing Model***

- Network computers are microcomputers without floppy or hard disk drives that are designed as low-cost networking computing devices.

* "Introduction to Information Systems" by James O'Brien, George M. Marakas, 11th edition, McGraw Hill, Page No. 242

- Application and database servers provide the operating system, application software, applets, databases, and database management software needed by the end users in the network.

  After we have all the necessary pre-requisites for network communication, a structure must be put in place that organizes the way communication and sharing occurs on the basis of which many models are recognized. The two basic models of computing are discussed as below:

  - **Centralized Computing:** Centralized computing is computing done at a central location, using terminals that are attached to a central computer. The computer itself may control all the peripherals directly (if they are physically connected to the central computer), or they may be attached via a terminal server. It offers greater security over decentralized systems because all of the processing is controlled in a central location. In addition, if one terminal breaks down, the user can simply go to another terminal and log in again, and all of their files will still be accessible. Depending on the system, they may even be able to resume their session from the point they were at before, as if nothing had happened.

    This type of arrangement does have some disadvantages.

    - The central computer performs the computing functions and controls the remote terminals. This type of system relies totally on the central computer. Should the central computer crash, the entire system will "go down" (i.e. will be unavailable).
    - Central computing relies heavily on the quality of administration and resources provided to its users. Should the central computer be inadequately supported by any means (e.g. size of home directories, problems regarding administration), then your usage will suffer greatly.

    The reverse situation, however, (i.e., a system supported better than your needs) is one of the key advantages to centralized computing.

  - **Decentralized Computing:** Decentralized computing is the allocation of resources, both hardware and software, to each individual workstation, or office location. In contrast, centralized computing exists when the majority of functions are carried out, or obtained from a remote centralized location. A collection of decentralized computers systems are components of a larger computer network, held together by local stations of equal importance and capability. These systems are capable of running independently of each other. Decentralized systems enable file sharing and all computers can share peripherals such as printers and scanners as well as modems, allowing all the computers in the network to connect to the internet.

However, in case of up-gradation, all computers have to be updated individually with new software, unlike a centralized computer system.

### 3.7.1 Network Topology

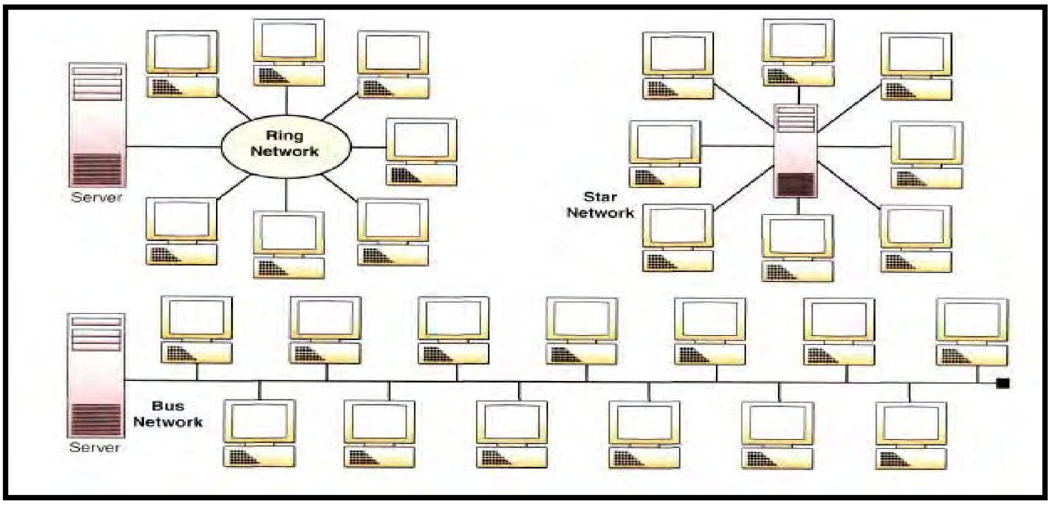



**Fig. 3.7.2: Ring, Star and Bus Topologies***

The term '**Topology'** defines the physical or logical arrangement of links in a network. It is the geometric representation of the relationship of all the links and linking devices (usually called Nodes) to each other. There are several basic types of network topologies, or structures, in telecommunications networks as shown in the Fig. 3.7.2. Four basic topologies used in wide area and local area telecommunications networks are as follows:

- Star network
- Ring network
- Bus network
- Mesh Network

**A. Star Network:** The star network, a popular network configuration, involves a central unit that has a number of terminals tied into it. The characteristics of a star network are:

- It ties end user computers to a central computer.
- The central unit in the star network acts as the traffic controller among all the other computers tied to it. The central computer is usually a mainframe (host), which acts as the file server.
- A star network is well suited to companies with one large data processing facility shared by a number of smaller departments. Many star networks take the form of hierarchical networks with a centralized approach.

* "Introduction to Information Systems" by James O'Brien, George M. Marakas, 11th edition, McGraw Hill, Page No.254

**Advantages of the star network include the following:**

- Several users can use the central unit at the same time.
- It is easy to add new nodes and remove existing nodes.
- A node failure does not bring down the entire network.
- It is easier to diagnose network problems through a central hub.

**Disadvantages of the star network are as follows:**

- The whole network is affected if the main unit "goes down," and all communications stop.
- Considered less reliable than a ring network, since the other computers in the star are heavily dependent on the central host computer. If it fails, there is no backup processing and communications capability and the local computers will be cut off from the corporate headquarters and from each other.
- Cost of cabling the central system and the points of the star network together are very high.

**B. Bus Network:** In a bus network, a single length of wire, cable, or optical fiber connects a number of computers. The features of a bus network are as follows:

- All communications travel along this cable, which is called a bus.
- Bus networks have a decentralized approach.

**Advantages of bus network include the following:**

- There is no host computer or file server, which makes bus network reliable as well as easy to use and understand.
- If one of the microcomputers fails, it will not affect the entire network.
- Requires the least amount of cable to connect the computers together and therefore is less expensive than other cabling arrangements.
- Is easy to extend. Two cables can be easily joined with a connector, making a longer cable for more computers to join the network.
- A repeater can also be used to extend a bus configuration.

**Disadvantages of bus network include the following:**

- Heavy network traffic can slow a bus considerably since any computer can transmit at any time. But networks do not coordinate when information is sent. Computers interrupting each other can use a lot of bandwidth.
- Each connection between two cables weakens the electrical signal.
- The bus configuration can be difficult to troubleshoot. A cable break or malfunctioning computer can be difficult to find and can cause the whole network to stop functioning.

C. **Ring Network:** A ring network is much like a bus network, except the length of wire, cable, or optical fiber connects to form a loop. The characteristics of a ring network are:

- Local computer processors are tied together sequentially in a ring with each device being connected to two other devices.
- A ring network has a decentralized approach.
- When one computer needs data from another computer, the data is passed along the ring.
- Considered more reliable and less costly than star networks because if one computer fails, the other computers in the ring can continue to process their own work and communicate with each other.

**Advantages of ring network include the following:**

- Ring networks do not require a central computer to control activity nor does it need a file server.
- Each computer connected to the network can communicate directly with the other computers in the network by using the common communication channel, and each computer does its own independent applications processing.
- The ring network is not as susceptible to breakdowns as the star network, because when one computer in the ring fails, it does not necessarily affect the processing or communications capabilities of the other computers in the ring.
- Ring networks offer high performance for a small number of workstations or for larger networks where each station has a similar workload.
- Ring networks can span longer distances than other types of networks.
- Ring networks are easily extendable.

**Disadvantages of ring network are as follows:**

- Relatively expensive and difficult to install.
- Failure of one computer on the network can affect the whole network.
- It is difficult to troubleshoot a ring network.
- Adding or removing computers can disrupt the network.

D. **Mesh Network:** In this structure, there is random connection of nodes using communication links. A mesh network may be fully connected (as shown in Fig 3.7.3) or connected with only partial links. In fully interconnected topology, each node is connected by a dedicated point to point link to every node. The reliability is very high as there are always alternate paths available if direct link between two nodes is down or dysfunctional. Fully connected networks are not very common because of the high cost. Only military installations, which need high degree of redundancy, may have such networks, that too with a small number of nodes.

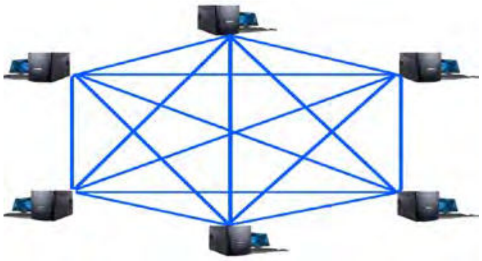


**Fig. 3.7.3: Mesh Network**

**Advantages of mesh network are as under:**

- Yields the greatest amount of redundancy in the event that if one of the nodes fails, the network traffic can be redirected to another node.
- Network problems are easier to diagnose.

**Disadvantage of mesh network** is its high cost of installation and maintenance (more cable is required than any other configuration).

### 3.7.2 Digital Data Transmission

Binary data, consisting of 1s and 0s, may be organized into groups of n bits each. Computers produce and consume data in groups of bits such as we conceive of and use spoken language in the form of words rather than letters. A given transmission on a communication channel between two machines can be accomplished either in **Parallel mode** or **Serial mode**. Further, while there is only one way to send parallel data, there are two subclasses of serial transmission: **Asynchronous** and **Synchronous**. (As listed in Fig. 3.7.4)

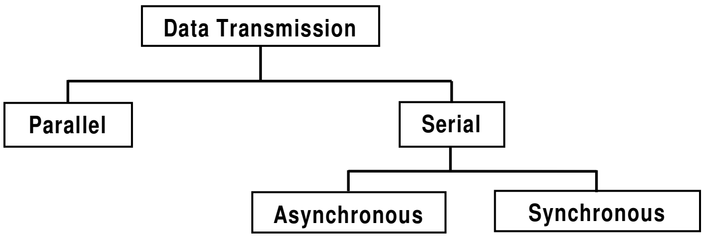



**Fig. 3.7.4: Data Transmission**

**A. Serial versus Parallel Transmission:** The transmission of binary data across a link can be accomplished either in **Serial Mode** or **Parallel Mode**.

- **Parallel Transmission:** In Parallel transmission, there are separate parallel paths corresponding to each bit of the byte so that all character bits are transmitted simultaneously as shown in Fig 3.7.5. Centronic port is the example of parallel port used for printer.

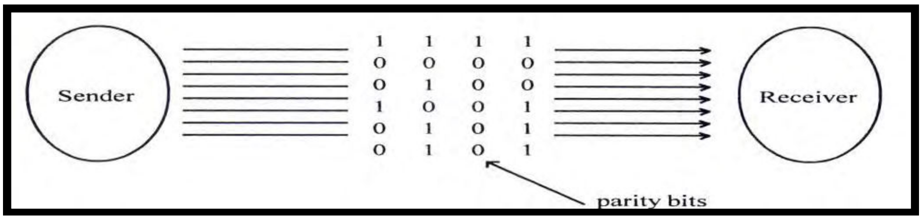



**Fig. 3.7.5: Parallel Transmission**

- **Serial Transmission:** In serial transmission, the bits of each byte are sent along a single path one after another as illustrated in Fig 3.7.6. As one bit follows another, so only one communication channel is required between two communicating devices. RS-232 is an example of serial port used for the mouse or MODEM.

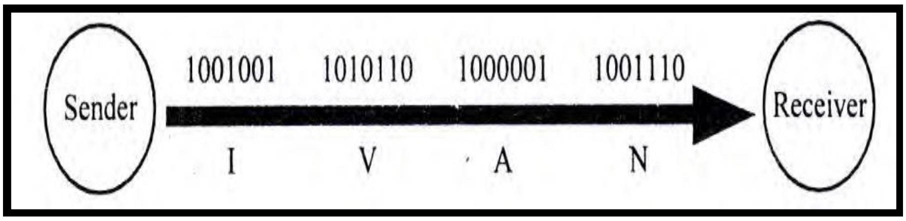



**Fig. 3.7.6: Serial Transmission**

Table 3.7.1 highlights major differences between Serial Transmission and Parallel Transmission.

**Table 3.7.1: Serial Transmission versus Parallel Transmission**

| S.No | Serial Transmission | Parallel Transmission |
|---|---|---|
| 1 | In this, the data bits are transmitted serially one after another. | In this, the data bits are transmitted simultaneously. |
| 2 | Data is transmitted over a single wire. | Data is transmitted over 8 different wires. |
| 3 | It is a cheaper mode of transferring data. | It is relatively expensive mode of transferring data. |
| 4 | It is useful for long distance data transmissions. | Not practical for long distance communications as it uses parallel paths, so cross talk may occur. |
| 5 | It is relatively slower. | It is relatively faster. |

As in serial connections, wherein a single wire transports the data, the problem is how to synchronize the transmitter and receiver, in other words, the receiver can not necessarily distinguish the characters (or more generally the bit sequences) because the bits are sent one after the other. When a computer sends the data bits and parity bit down the same communication channel, the data are grouped together in predetermined bit patterns for the receiving devices to recognize when each byte (character) has been transmitted. There are two basic ways of transmitting serial binary data that addresses the problem of sequencing and re-arranging of data at receiver end: **Asynchronous** and **Synchronous**. There are two types of transmission that address this problem:

- **Asynchronous Transmission:** In this, each character is sent at irregular intervals in time as in the case of characters entered at the keyboard in real time. So, the sender provides a synchronization signal to the receiver before starting the transfer of each message. For example, imagine that a single byte is transmitted during a long period of silence... the receiver will not be able to know if this is 00010000, 10000000 or 00000100. To correct this problem, each character is preceded by some information indicating the start of character transmission by start-of-transmission information (called a **START** bit usually 0) and ends by sending end-of-transmission information (called **STOP** bit usually 1), as shown in Fig 3.7.7.

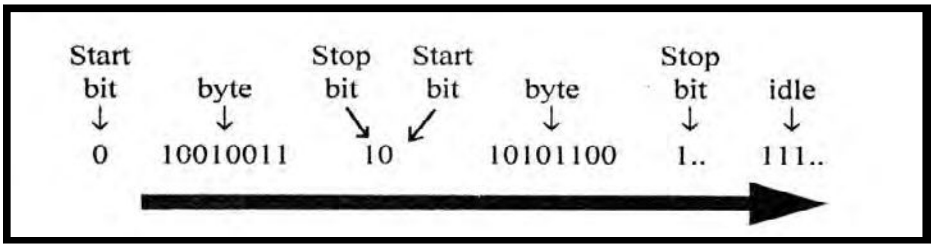



**Fig. 3.7.7: Asynchronous Transmission**

- **Synchronous Transmission:** In this, the transmitter and receiver are paced by the same clock. The receiver continuously receives (even when no bits are transmitted) the information at the same rate the transmitter sends it. This is why the transmitter and receiver are paced at the same speed. In addition, supplementary information is inserted to guarantee that there are no errors during transmission, as shown in Fig 3.7.8.

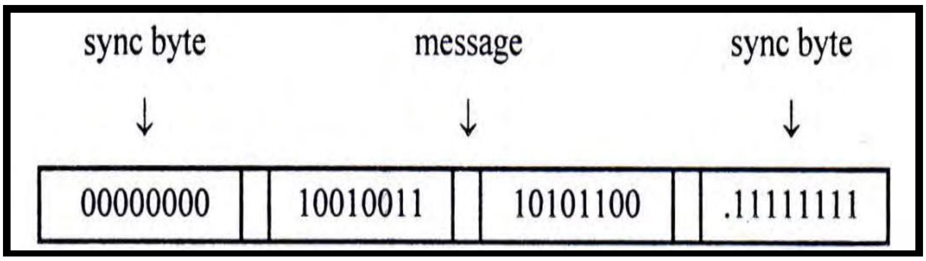



**Fig. 3.7.8: Synchronous Transmission**

A group of synchronization bits must be placed at the beginning and ending of each block to maintain synchronization.

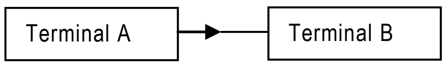
Table 3.7.2 lists the differences between Asynchronous and Synchronous Transmission.

**Table 3.7.2: Asynchronous vs Synchronous Transmission**

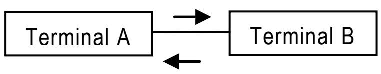
| S.No. | ASYNCHRONOUS TRANSMISSION | SYNCHRONOUS TRANSMISSION |
|---|---|---|
| 1 | Each data word is accompanied by Start and Stop bits. | Allows characters to b e sent down the line without Start-Stop bits. |
| 2 | Extra Start and Stop bits slow down the transmission process relatively. | Transmission is faster as in absence of Start and Stop bits, many data words can be transmitted per second. |
| 3 | It is relatively cheaper as it requires less hardware. | The synchronous device is more expensive to build as it must be smart enough to differentiate between the actual data and the special synchronous characters. |
| 4 | More reliable as the Start and Stop bits ensure that the sender and the receiver remain in step with one another. | Chances of data loss are relatively higher. |
| 5 | It is less efficient as it is relatively more complex. | It is more efficient and has greater throughput. |

**B. Transmission Mode:** The **Transmission Mode** is used to define the direction of signal flow between two linked devices. There are three types of transmission modes characterized according to the direction of the exchanges: **Simplex, Half-Duplex** and **Duplex**.

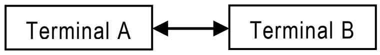
- **Simplex:** In **Simplex mode**, the data flows in only one direction (ie.. unidirectional) from the transmitter to the receiver. This type of connection is useful if the data do not need to flow in both directions. For example, Keyboards can only introduce input and printer can only receive the data.




- **Half-Duplex:** In **Half-Duplex mode,** (sometimes called an alternating connection or semi-duplex) the data flows in one direction or the other, but not both at the same time. This type of connection makes it possible to have bidirectional communications using the full capacity of the line. For example: Walkie Talkie. In this, the entire capacity of a channel is taken over by whichever of the two devices is transmitting at the time.




- **Full-Duplex:** In **Full-Duplex mode**, the data flows in both directions simultaneously. Each end of the line can thus transmit and receive at the same time, which means that the bandwidth is divided in two for each direction of data transmission if the same transmission medium is used for both directions of transmission. For example: Mobile Phones. In this, signals going in either direction share the capacity of the link wither by containing two separate physical links (one for sending and the other for receiving) or by dividing the capacity of the channel between signals travelling in opposite direction.




**C. Transmission Techniques:** A communication network consists of a collection of devices (or nodes) that wish to communicate and interconnect together. The primary objective in any communication network is simply moving information from one source to one or more destination nodes. Based on the techniques used to transfer data, communication networks can be categorized into **Broadcast** and **Switched networks**.

- **Broadcast Networks -** In **Broadcast networks**, data transmitted by one node is received by many, sometimes all, of the other nodes as shown in the Fig. 3.7.9. This refers to a method of transferring a message to all recipients simultaneously. For example – a corporation or other voluntary association, that provides live television or recorded content such as movies, newscasts, sports, public affairs programming, and other television programs for broadcast over a group of radio stations or television stations.

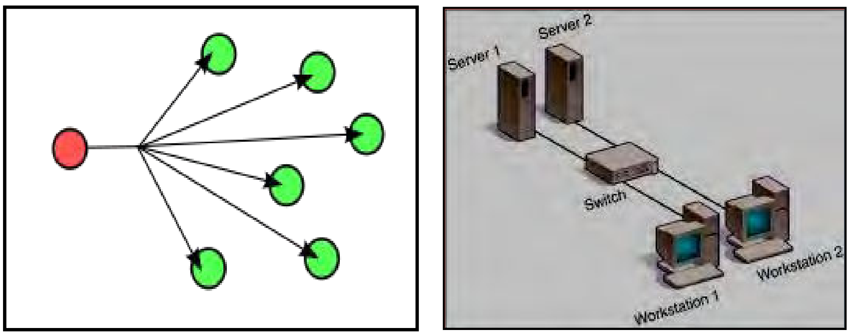



**Fig. 3.7.9: Broadcast and Switched networks respectively**

- **Switched Networks -** In **switched-communication networks**, the data transferred from source to destination is routed through the switch nodes as shown in the Fig. 3.7.9. The way in which the nodes switch data from one link to another, as it is transmitted from source to destination node, is referred to as a switching technique. Three common switching techniques are **Circuit Switching, Packet Switching, and Message Switching**.

  (i) **Circuit Switching:** A **Circuit Switching** network is one that establishes a fixed bandwidth circuit (or channel) between nodes and terminals before the users may communicate, as if the nodes were physically connected with an electrical circuit. The route is dedicated and exclusive, and released only when the communication session terminates. Circuit switching is what most of us encounter on our home phones. A single circuit is used for the entire duration of the call. Applications which use circuit switching go through three phases: **Establish a Circuit, Transfer of data** and **Disconnect the Circuit.**

(ii) **Packet Switching:** It is a sophisticated means of maximizing transmission capacity of networks. **Packet switching** refers to protocols in which messages are broken up into small transmission units called packets, before they are sent. Each packet is transmitted individually across the net. The packets may even follow different routes to the destination. Since there is no fixed path, different packets can follow different path and thus they may reach to destination out of order.

(iii) **Message Switching:** In **message switching**, end-users communicate by sending each other a message, which contains the entire data being delivered from the source to destination node. As a message is routed from its source to its destination, each intermediate switch within the network stores the entire message, providing a very reliable service. The intermediary nodes (switches) have the responsibility of conveying the received message from one node to another in the network. Therefore, each intermediary node within the network must store all messages before retransmitting them one at a time as proper resources become available. This characteristic is often referred to as **Store-and-Forward**. Electronic mail (e-mail) and voice mail are examples of message switching systems.

### 3.7.3 Network Architectures and Protocols

**Network Architecture: Network Architecture** refers to the layout of the network consisting of the hardware, software, connectivity, communication protocols and mode of transmission, such as wired or wireless. The diagram of the network architecture provides a full picture of the established network with detailed view of all the resources accessible.

In other words, Network Architecture includes hardware components used for communication, cabling and device types, network layout and topologies, physical and wireless connections, implemented areas and future plans. In addition, the software rules and protocols also constitute to the network architecture. This architecture is always designed by a network manager/administrator with coordination of network engineers and other design engineers.

The goal of network architecture is to promote an open, simple, flexible, and efficient telecommunications environment. This is accomplished by the use of Standard protocols; Standard communications hardware and software interfaces; and standard multilevel interface between end users and computer systems.

The network architecture of the Internet is predominantly expressed by its use of the Internet Protocol Suite, rather than a specific model for interconnecting networks or nodes in the network, or the usage of specific types of hardware links.

**Protocols**: **Protocols** are software that performs a variety of actions necessary for data transmission between computers. Stated more precisely, protocols are a set of rules for inter-computer communication that have been agreed upon and implemented by many vendors, users and standards bodies to ensure that the information being exchanged between the two parties is received and interpreted correctly. Ideally, a protocols standard allows heterogeneous computers to talk to each other.

At the most basic level, protocols define the physical aspects of communication, such as how the system components will be interfaced and at what voltage levels will be transmitted.

At higher levels, protocols define the way that data will be transferred, such as the establishment and termination of "sessions" between computers and the synchronization of those transmissions. At still higher levels, protocols can standardize the way data itself is encoded and compressed for transmission. Thus we can say that, Network protocols which are essentially software are sets of rules for-

- ♦ Communicating timings, sequencing, formatting, and error checking for data transmission.
- ♦ Providing standards for data communication.

A **protocol** defines the following three aspects of digital communication.

(a) **Syntax:** The format of data being exchanged, character set used, type of error correction used, type of encoding scheme (e.g., signal levels) being used.

(b) **Semantics:** Type and order of messages used to ensure reliable and error free information transfer.

(c) **Timing:** Defines data rate selection and correct timing for various events during data transfer.

As stated earlier, communication protocols are rules established to govern the way the data are transmitted in a computer network. These rules are embedded or built into the software which resides either in – Computer's memory or Memory of transmission device. Different protocols cannot talk to each other hence standard protocols have been structured to resolve the problem. The entire operation of data transmission over a network is broken down into discrete systematic steps. Each step has its own rules or protocol. Steps must be carried out in consistent order for every computer in the network, either receiving or sending data.

At the sending computer, protocols –

(i) Break data down into packets;

(ii) Add destination address to the packet; and

(iii) Prepares data for transmission through Network Interface Card (NIC)

At the receiving computer, protocols –

(i) Take data packets off the cable;

(ii) Bring packets into computer through Network Interface Card (NIC;

(iii) Strip the packets off any transmitting information;

(iv) Copy data from packet to a buffer for reassembly; and

(v) Pass the reassembled data to the application.

## A. The OSI Model

The **International Standards Organization (ISO)** developed a seven-layer Open Systems Interconnection (OSI) model to serve as a standard model for network architectures. Dividing data communications functions into seven distinct layers promotes the development of modular network architectures, which assists the development, operation, and maintenance of complex telecommunications networks. Seven layers of OSI include the following:

- **Layer 7 or Application Layer:** The application layer of OSI layer architecture is closest to the end user, which means that both the OSI application layer and the user interact directly with the software application. This layer interacts with software applications and provides user services by file transfer, file sharing, etc. Database concurrency and deadlock situation controls are undertaken at this layer level. This is the layer at which communication partners are identified, quality of service is identified, user authentication and privacy are considered, and any constraints on data syntax are identified.
- **Layer 6 or Presentation Layer:** This layer at times referred as **Syntax Layer** also, is usually a part of an operating system, that converts incoming and outgoing data from one presentation format to another (for example, from a text stream into a popup window with the newly arrived text). The presentation service data units are then encapsulated into Session Protocol Data Units, and moved down the stack. It further controls on screen display of data, transforms data to a standard application interface. Encryption, data compression can also be undertaken at this layer level.
- **Layer 5 or Session Layer:** This layer sets up, coordinates, and terminates conversations, exchanges, and dialogs between the applications at each end. It deals with session and connection coordination. It provides for full-duplex, half-duplex, or simplex operation, and establishes check pointing, adjournment, termination, and restart procedures. The OSI model made this layer responsible for "graceful close" of sessions also.
- **Layer 4 or Transport Layer:** This layer ensures reliable and transparent transfer of data between user processes, assembles and disassembles message packets, and provides error recovery and flow control. Multiplexing and encryption are undertaken at this layer level. This means that the Transport Layer can keep track of the segments and retransmit those that fail.
- **Layer 3 or Network Layer:** The Network Layer provides the functional and procedural means of transferring variable length data sequences from a source to a destination via

one or more networks, while maintaining the quality of service requested by the Transport Layer. The Network Layer makes a c hoice of the physical route of transmission, creates a virtual circuit for upper layers to make them independent of data transmission and switching, establishes, maintains, terminates connections between the nodes and ensure proper routing of data.

- **Layer 2 or Data Link Layer:** The Data Link Layer responds to service requests from the Network Layer and issues service requests to the Physical Layer. The Data Link Layer is the protocol layer which transfers data between adjacent network nodes in a wide area network or between nodes on the same local area network segment. This layer is also a hardware layer which specifies channel access control method and ensures reliable transfer of data through the transmission medium. It provides the functional and procedural means to transfer data between network entities and to detect and possibly correct errors that may occur in the Physical Layer.
- **Layer 1 or Physical Layer:** The Physical Layer is a hardware layer which specifies mechanical features as well as electromagnetic features of the connection between the devices and the transmission. In particular, it defines the relationship between a device and a physical medium. This includes the layout of pins, voltages, cable specifications, Hubs, repeaters, network adapters, Host Bus Adapters (HBAs used in Storage Area Networks) and more. The major functions and services performed by the Physical Layer are as follows:
  - Establishment and termination of a connection to a communications medium.
  - Participation in the process whereby the communication resources are effectively shared among multiple users. For example, contention resolution and flow control.
  - Modulation or conversion between the representation of d igital data in user equipment and the corresponding signals transmitted over a communications channel. These are signals operating over the physical cabling (such as copper and optical fiber) or over a radio link.

## B. Internet's TCP/IP

The Internet uses a system of telecommunications protocols that has become so widely used that it is equivalent to network architecture. The Internet's protocol suite is called **Transmission Control Protocol /Internet Protocol** and is known as TCP/IP. TCP/IP consists of five levels of protocols that can be related to the seven layers of the OSI architecture. TCP/IP is used by the Internet and by all Intranets and extranets. Many companies and other organizations are also converting their client/server networks to TCP/IP.

Five levels of TCP/IP include as shown in the Fig. 3.7.10 are as follows:

- Application or process layer
- Host-to-Host Transport layer
- Internet Protocol (IP)
- Network Interface

♦ Physical layer

| TCP/IP | | The OSI Model | |
|---|---|---|---|
| Application or Process Layer | | Application Layer | Provides communications services for end user applications |
| | | Presentation Layer | Provides appropriate data transmission formats and codes |
| | | Session Layer | Supports the accomplishment of telecommunications sessions |
| Host-to-Host Transport Layer | | Transport Layer | Supports the organization and transfer of data between nodes in the network |
| Internet Protocol (IP) | | Network Layer | Provides appropriate routing by establishing connections among network links |
| Network Interface | | Data Link Layer | Supports error-free organization and transmission of data in the network |
| Physical Layer | | Physical Layer | Provides physical transmission of data on the telecommunications media in the network |

**Fig. 3.7.10: Relationship between layers of TCP/IP and OSI Model***

## 3.8 Network Risks, Controls and Security

The basic objective for providing network security is two-fold. It is:

(i) to safeguard assets, and

(ii) to ensure and maintain the data integrity.

The boundary subsystem is an interface between the potential users of a system and the system itself. Controls in the boundary subsystem have the following purposes like it is used:

* "Introduction to Information Systems" by James O'Brien, George M. Marakas, 11th edition, McGraw Hill

(i) to establish the system resources that the users desire to employ and

(ii) to restrict the actions undertaken by the users who obtain the system resource to an authorized set.

There are two types of Systems Security.

- **Physical Security:** A **Physical security** is implemented to protect the physical systems assets of an organization like the personnel, hardware, facilities, supplies and documentation.
- **Logical Security:** A **Logical security** is intended protect data/information and software. Security administrators tend to have responsibility for controls over
  - (i) malicious and non-malicious threats to physical security, and
  - (ii) malicious threats to logical security itself.

### 3.8.1 Threats and Vulnerabilities

**Threat:** A **Threat** is a possible danger that can disrupt the operation, functioning, integrity, or availability of a network or system. Network security threats can be categorized into four broad themes:

♦ **Unstructured Threats** - These originate mostly from inexperienced individuals using easily available hacking tools from the Internet. Many tools available to anyone on the Internet can be used to discover weaknesses in a company's network. These include port-scanning tools, address-sweeping tools, and many others. Most of these kinds of probes are done more out of curiosity than with a malicious intent in mind.

  For example, if a company's external web site is hacked; the company's integrity is damaged. Even if the external web site is separate from the internal information that sits behind a protective firewall, the public does not know that. All they know is that if the company's web site is hacked, then it is an unsafe place to conduct business.

♦ **Structured Threats** - These originate from individuals who are highly motivated and technically competent and usually understand network systems design and the vulnerabilities of those systems. They can understand as well as create hacking scripts to penetrate those network systems. An individual who presents a structured threat typically targets a specific destination or group. Usually, these hackers are hired by industry competitors, or state-sponsored intelligence organizations.

♦ **External Threats** - These originate from individuals or organizations working outside an organization, which does not have authorized access to organization's computer systems or network. They usually work their way into a network from the Internet or dialup access servers.

♦ **Internal Threats** - Typically, these threats originate from individuals who have authorized access to the network. These users either have an account on a server or physical access to the network. An internal threat may come from a discontented former or current employee or contractor. It has been seen that majority of security incidents originate from internal threats.

**Vulnerability: Vulnerability** is an inherent weakness in the design, configuration, or implementation of a network or system that renders it susceptible to a threat.

The following facts are responsible for occurrence of vulnerabilities in the software:

- **Software Bugs** - Software bugs are so common that users have developed techniques to work around the consequences, and bugs that make saving work necessary every half an hour or crash the computer every so often are considered to be a normal part of computing. For example - buffer overflow, failure to handle exceptional conditions, access validation error, input validation errors are some of the common software flaws.
- **Timing Windows** - This problem may occur when a temporary file is exploited by an intruder to gain access to the file, overwrite important data, and use the file as a gateway for advancing further into the system.
- **Insecure default configurations** - Insecure default configurations occur when vendors use known default passwords to make it as easy as possible for consumers to set up new systems. Unfortunately, most intruders know these passwords and can access systems effortlessly.
- **Trusting Untrustworthy information** - This is usually a problem that affects routers, or those computers that connect one network to another. When routers are not programmed to verify that they are receiving information from a unique host, bogus routers can gain access to systems and do damage.
- **End users** - Generally, users of computer systems are not professionals and are not always security conscious. For example, when the number of passwords of an user increases, user may start writing them down, in the worst case to places from where they are easy to find. In addition to this kind of negligence towards security procedures users do human errors, for example save confidential files to places where they are not properly protected.

### 3.8.2 Level of Security

The task of a Security Administration in an organization is to conduct a security program which is a series of ongoing, regular and periodic review of controls exercised to ensure safeguarding of assets and maintenance of data integrity. Security programs involve the following eight steps –

**(i)** **Preparing project plan for enforcing security:** The project plan components are at first outlining the objectives of the review followed by in sequence determining the scope of the review and tasks to be accomplished, assigning tasks to the project team after organizing it, preparing resources budget which will be determined by the volume and complexity of the review and fixing a target / schedule for task completion.

**(ii) Asset identification:** Assets which need to be safeguarded can be identified and subdivided into Personnel, Hardware, Facilities, Documentation, Supplies, Data, Application Software and System Software.

**(iii) Asset valuation:** This step of valuation of assets can pose a difficulty. The process of valuation can differ depending on who is asked to render the valuation, the way in which the asset can be lost and the period for which it is lost and how old is the asset.

Valuation of physical assets cannot be considered apart from the valuation of the logical assets. For example, the replacement value of the contents in a micro computer's hard disk may be several times more than the replacement value of the disk itself.

**(iv) Threat identification:** The source of a threat can be external or internal and the nature of a threat can be accidental / non-deliberate or deliberate. The example of a non-deliberate external threat is an act of God, non-deliberate internal threat is pollution, deliberate external threat is hackers, and deliberate internal threat is employees.

**(v) Threats probability of occurrence assessment:** This step is an assessment of the probability of occurrence of threats over a given time period. This exercise is not so difficult if prior period statistical data is available. If however, prior period data is not available, it has to be elicited from the associated stakeholders like end users (furnishing the data aspect) and the management (furnishing the control aspect).

**(vi) Exposure analysis:** This step is the Exposures Analysis by first identifying the controls in the place, secondly assessing the reliability of the existing controls, thirdly evaluating the probability that a threat can be successful and lastly assessing the resulting loss if the threat is successful. For each asset and each threat the expected loss can be estimated as the product of the probability of threat occurrence, probability of control failure and the resulting loss if the threat is successful.

**(vii) Controls adjustment:** The involves the adjustment of controls which means whether over some time period any control can be designed, implemented and operated such that the cost of control is lower than the reduction in the expected losses. The reduction in the expected losses is the difference between expected losses with the (i) existing set of controls and (ii) improved set of controls.

**(viii) Report generation outlining the levels of security to be provided for individual systems, end user, etc.:** This is the last step that involves report generation documenting, the findings of the review and specially recommending new assets safeguarding techniques that should be implemented and existing assets safeguarding mechanisms that should be eliminated / rectified, and also recommending the assignment of the levels of security to be pervaded for individual end users and systems.

### 3.8.3 Network Security

Network security is becoming more and more crucial as the volume of data being exchanged on the Internet increases. Based on the increasing demand and expectations, the security involves four aspects: **Privacy (Confidentiality), Message Authentication, Message Integrity** and **Non-repudiation.** Network Security Protocols are primarily designed to prevent any unauthorized user, application, service or device from accessing network data. This applies to virtually all data types regardless of the network medium used. Network security protocols generally implement digital signatures, cryptography and encryption techniques.

(a) **Privacy:** This means that the sender and the receiver expect confidentiality. The transmitted message should make sense to only the intended receiver and the message should be un intelligible to un authorized users. This is achieved by cryptography and encryption techniques so that the data is secured and can only be decrypted with a special algorithm, logical key, mathematical formula and/or a combination of all of them.

- **Cryptography:** Cryptography is the practice and study of t echniques for secure communication in the presence of third parties (called Adversaries). More generally, it is about constructing and analyzing protocols that overcome the influence of adversaries and which are related to various aspects in information security such as data confidentiality, integrity, authentication, and non-repudiation.

- **Encryption:** In Cryptography, encryption is the process of encoding messages (or information) in such a w ay that eavesdroppers or hackers cannot read it, but only authorized parties can. Decryption is defined as the recovery of the original message from the encrypted data.

    - **Plaintext -** It is the message that is to be encrypted. It is transformed by a function that is parameterized by a key.

    - **CipherText -** It is the output of the encryption process that is transmitted often by a messenger or radio.

    - **Encryption Model -** The intruder may hear and accurately copies down the complete ciphertext. However, unlike the intended recipient, he does not know what the decryption key is and so cannot decrypt the ciphertext easily. Sometimes the intruder can not only listen to the communication channel (passive intruder) but can also record messages and play them back later, inject his own messages, or modify legitimate messages before they get to the receiver (active intruder). The art of breaking ciphers is known as **Cryptanalysis** and the art of devising them is known as **Cryptography**. Both Cryptanalysis and Cryptography are collectively known as **Cryptology**. Refer to the Fig. 3.8.1.

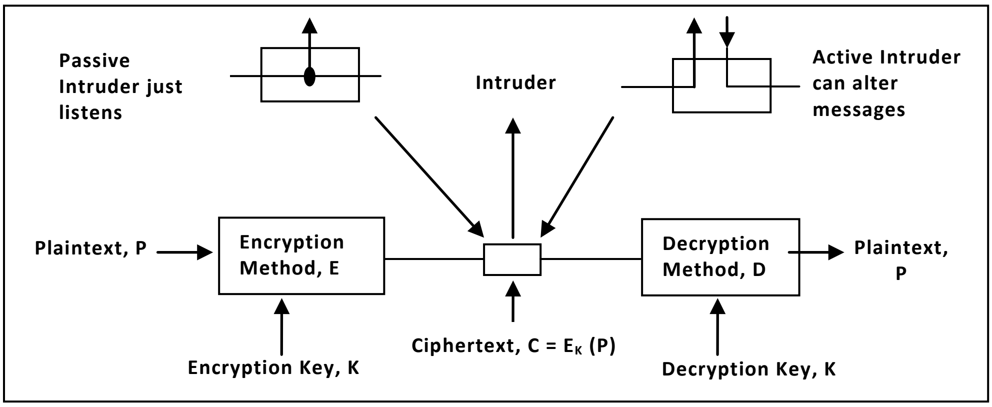



**Fig. 3.8.1: Encryption Model**

- There are two categories of encryption/decryption methods: the **Secret Key Method** and the **Public Key Method**.
  - In **Secret key encryption/decryption method**, the same key is used by both sender and the receiver. The sender uses this key and an encryption algorithm to encrypt data; the receiver uses the same key and the corresponding decryption algorithm to d ecrypt the data. In t his, the algorithm used for decryption is the inverse of the algorithm used for encryption.
  - In **Public key encryption**, there are two keys: a private key and a public key. The private key is kept by the receiver and the public key is announced to the public.
- There are two basic approaches to encryption:
  - **Hardware encryption** devices are available at a reasonable cost, and can support high- speed traffic. If th e Internet is being used to e xchange information among branch offices or development collaborators, for instance, use of such devices can ensure that all traffic between these offices is secure.
  - **Software encryption** is typically employed in conjunction with specific applications. Certain electronic mail packages, for example, provide encryption and decryption for message security.

(b) **Authentication:** This means that the receiver is sure of the sender's identity and that an imposter has not sent the message.

(c) **Integrity:** This means that the data must arrive at the receiver exactly as it was sent. There must not be any changes during the transmission – either accidental or malicious.

(d) **Non-Repudiation:** This means that a receiver must be able to prove that a received message came from a specific sender and the sender must not be able to deny sending it.

These can be achieved using **Digital Signatures**. Public key encryption can be used to sign a document. However, the roles of the public and private key are different. The sender uses her private key to encrypt (sign) the message just as a person uses her signature (which is private in the sense that it is difficult to forge) to sign a paper document, The receiver, on the other hand, uses the public key of the sender to decrypt the message just as a person verifies from memory another person's signature. In digital signature, the private key is used for encryption and the public key for decryption.

### 3.8.4 Network Security Protocols

Some of the popular network security protocols include **Secure Shell (SSH), Secure File Transfer Protocol (SFTP), Secure Hypertext Transfer Protocol (HTTPS)** and **Secure Socket Layer (SSL)** etc.

- **SSH - Secure Shell (SSH)** is a program to log into another computer over a network, to execute commands in a remote machine, and to move files from one machine to another. It provides strong authentication and secure communications over insecure channels. SSH protects a network from attacks such as IP spoofing, IP source routing, and DNS spoofing. An attacker cannot play back the traffic or hijack the connection when encryption is enabled. During ssh login, the entire login session, including transmission of password, is encrypted; therefore it is almost impossible for an outsider to collect passwords.
- **SFTP** – The **SSH File Transfer Protocol** (also known as Secure FTP or SFTP) is a computing network protocol for accessing and managing files on remote file systems. Unlike standard File Transfer Protocol (FTP), SFTP encrypts commands and data both, preventing passwords and sensitive information from being transmitted in the clear over a network.
- **HTTPS – HyperText Transfer Protocol Secure (HTTPS)** is a communications protocol for secure communication over a computer network, with especially wide deployment on the Internet. The security of HTTPS uses long term public and secret keys to exchange a short term session key to encrypt the data flow between client and server.
- **SSL – Secure Socket Layer (SSL)** is essentially a protocol that provides a secure channel between two machines operating over the Internet or an internal network. In today's Internet focused world, the SSL protocol is typically used when a web browser needs to securely connect to a web server over the inherently insecure Internet. In practice, SSL is used to secure online credit card transactions, system logins and any sensitive information exchanged online, to secure webmail and applications like Outlook Web Access, Exchange and Office Communications Server, to secure the connection

between an email client such as Microsoft Outlook and an email server such as Microsoft Exchange, to secure intranet based traffic such as internal networks, file sharing, extranets, and database connections etc.

### 3.8.5 Network Security Techniques

As data is shared and organizations become connected to the outside world, the possibility of data exposure to vendors, service providers, and trading partners is significantly increased. In spite of the varied concerns, corporations understand that the Internet is clearly the most promising infrastructure for “anywhere, anytime” electronic communication between businesses, customers, and suppliers; and progress is being made as companies further realize and respond to these concerns. Several tools/technologies are now available to protect information and systems against compromise, intrusion, or misuse. Some of them are as follows:

1. **Intrusion Detection System (IDS):** An **Intrusion Detection System** is a device or software application that monitors network or system activities for malicious activities or policy violations and produces reports to a Management Station. The goal of intrusion detection is to monitor network assets to detect anomalous behavior and misuse. IDS are primarily of two types:

   (i) **Network Intrusion Detection (NID):** Network Intrusion Detection System is placed on a network to analyze traffic in search of unwanted or malicious events on the wire between hosts. Typically referred to as "packet-sniffers", network intrusion detection devices intercept packets traveling along various communication mediums and protocols, usually TCP/IP. NNID is a type of NID. The advantage of NNID is its ability to defend specific hosts against packet-based attacks in these complex environments where conventional NID is ineffective.

   (ii) **Host-based Intrusion Detection (HID):** Host-based Intrusion Detection systems are designed to monitor, detect, and respond to user and system activity and attacks on a given host. The difference between host-based and network-based intrusion detection is that NID deals with data transmitted from host to host while HID is concerned with what occurs on the hosts themselves. Host-based intrusion detection is best suited to combat internal threats because of its ability to monitor and respond to specific user actions and file accesses on the host. In other words, HID detects insider misuse while NID detects outsider misuse.

   **(iii) Hybrid Intrusion Detection:** Hybrid Intrusion Detection systems offer management of and alert notification from both network and host-based intrusion detection devices. Hybrid solutions provide the logical complement to NID and HID - central intrusion detection management.

2. **Firewall:** Firewall is a device that forms a barrier between a secure and an open environment when the latter environment is usually considered hostile, for example, the Internet. It acts as a system or combination of systems that enforces a boundary between

more than one networks. Access controls are common form of controls encountered in the boundary subsystem by restricting the use of system resources to authorized users, limiting the actions authorized users can take with these resources and ensuring that the users obtain only authentic system resources.

3. **Network Access Control:** Network Access Control (NAC) products enforce security policy by granting only security policy–compliant devices access to network assets. They handle access authentication and authorization functions and can even control the data that specific users' access, based on their ability to recognize users, their devices and their network roles.

4. **Anti – Malware:** Malware, short for malicious software, is any software used to disrupt computer operation, gather sensitive information, or gain access to private computer systems. It is an umbrella term used to refer to a variety of forms of hostile or intrusive software, including computer viruses, worms, trojan horses etc. and other malicious programs. Anti-malware network tools help administrators identify block and remove malware. They enable the IT department to tailor its anti-malware policies to identify known and unknown malware sources. Malware is always on the lookout for network vulnerabilities - in security defenses, operating systems, browsers, applications and popular targets such as Adobe Flash, Acrobat and Reader - that they can exploit to fully access a victim's network. Best practices call for a multipronged defense that might also include IP blacklisting, data loss prevention (DLP) tools, anti-virus and anti-spyware software, web browsing policies, egress filtering, and outbound-traffic proxies.

5. **Site Blocking:** It is a software-based approach that prohibits access to certain Web sites that are deemed inappropriate by management. For example, sites that contain explicit objectionable material can be blocked to prevent employee's from accessing these sites from company Internet servers. In addition to blocking sites, companies can also log activities and determine the amount of time spent on the Internet and identify the sites visited.

## 3.9 Network Administration and Management

In computer networks, **Network Management** refers to the activities, methods, procedures, and tools that pertain to the **Operation**, **Administration**, **Maintenance**, and **Provisioning** of networked systems. Network management is essential to command and control practices and is generally carried out of a network operations center.

- **Operation** deals with keeping the network (and the services that the network provides) up and running smoothly. It includes monitoring the network to spot problems as soon as possible, ideally before users are affected.
- **Administration** deals with keeping track of resources in the network and how they are assigned. It includes all the "housekeeping" that is necessary to keep the network under control.

- **Maintenance** is concerned with performing repairs and upgrades—for example, when equipment must be replaced, when a router needs a patch for an operating system image, when a new switch is added to a network. Maintenance also involves corrective and preventive measures to make the managed network run "better", such as adjusting device configuration parameters.
- **Provisioning** is concerned with configuring resources in the network to support a given service. For example, this might include setting up the network so that a new customer can receive voice service.

A common way of characterizing network management functions is **FCAPS - Fault, Configuration, Accounting, Performance** and **Security.** FCAPS is the ISO Telecommunications Management Network model and framework for network management.

**(i) Fault Management** - A fault is an event that has a negative significance. The goal of fault management is to recognize, isolate, correct and log faults that occur in the network. Most fault management systems poll the managed objects for error conditions and present this information to the network manager. Fault management identifies and isolates network issues, proposes problem resolution, and subsequently logs the issues and associated resolutions.

**(ii) Configuration Management** - Monitors network and system configuration information so that the impact on network operations (hardware and software elements) can be tracked and managed. Network changes, additions, and deletions need to be coordinated with the network management personnel.

**(iii) Accounting Management** - Accounting management is concerned with tracking network utilization information, such that individual users, departments, or business units can be appropriately billed or charged for accounting purposes. For non-billed networks, accounting refers to administration whose primary goal is to administer the set of authorized users by establishing users, passwords, and permissions and to administer the operations of the equipment such as by performing software backup and synchronization.

**(iv) Performance Management** - Measures and makes network performance data available so that performance can be maintained and acceptable thresholds. It enables the manager to prepare the network for the future, as well as to determine the efficiency of the current network. The network performance addresses the throughput, network response times, packet loss rates, link utilization, percentage utilization, error rates and so forth.

**(v) Security Management** - Controls access to network resources as established by organizational security guidelines. Most network management systems address security regarding network hardware, such as someone logging into a router. Security management functions include managing network authentication, authorization, and auditing, such that both internal and external users only have access to appropriate network resources, configuration and management of network firewalls, intrusion detection systems, and security policies (such as access lists).

Functions that are performed as part of network management accordingly include controlling, planning, allocating, deploying, coordinating, and monitoring the resources of a network, network planning, frequency allocation, predetermined traffic routing to support balancing, cryptographic distribution authorization, configuration management, fault management, security management, management, bandwidth management, Route analytics and accounting management.

## 3.10 The Internet Revolution

The Internet is the largest ''network of networks'' today, and the closest model we have to the information superhighway of tomorrow. Some distinguishing features of the Internet include:

- The Internet does not have a central computer system or telecommunications center. Instead, each message sent on the Internet has a unique address code so any Internet server in the network can forward it to its destination.
- The Internet does not have a headquarters or governing body.
- The Internet is growing rapidly.

Table 3.10.1 shows the strategic capabilities of Internet along with their business applications.

**Table 3.10.1: Examples of the business value of e-Business Applications of Telecommunications Networks**

| Strategic Capabilities | e-Business Examples | Business Value |
|---|---|---|
| **Overcome geographic barriers:** Capture information about business transactions from remote locations. | Use the Internet and extranets to transmit customer orders from travelling salespeople to a corporate data centre for order processing and inventory control. | Provides better customer service by reducing delay in filling orders and improves cash flow by speeding up the billing of customers. |
| **Overcome time barriers:** Provide information to remote locations immediately after it is requested. | Credit authorization at the point of sale using online POS networks. | Credit inquiries can be made and answered in seconds. |
| **Overcome cost barriers:** Reduce the cost of more traditional means of communication. | Desktop videoconferencing between a company and its business partners using the Internet, Intranets, and Extranets. | Reduces expensive business trips; allows customers, suppliers, and employees to collaborate, thus improving the quality of decisions reached. |
| **Overcome structural barriers:** Support | Business-to-business electronic commerce websites for | Fast, convenient services lock in customers and |

| | | |
|---|---|---|
| linkages for competitive advantage. | transactions with suppliers and customers using the Internet and Extranets. | suppliers. |

### 3.10.1 Networks and the Internet

A **Computer Network** is two or more computers linked together to share information and/or resources. There are several types of computers networks, but the types most important are Local Area Network (LAN), the Internet, Extranet, and Intranet.

The **Internet** is the global computer network, or "information super-high way". The Internet developed from a v ariety of university and government–sponsored computer networks that have evolved and are not made up of m illions and millions of computers and sub networks throughout the world. The Internet is the network that serves as the backbone for the World Wide Web (WWW).

An **Intranet** is a company's private network accessible only to the employees of that company. The intranet uses the common standards and protocols of t he Internet. The purpose of an intranet is to distribute data or information to employees, to make shared data or files available, and to manage projects within the company.

An **Extranet** is similar to an Intranet except that it offers access to selected outsiders, such as buyers to an i ntranet except, and wholesalers in the supply chain. Extranets allow business partners to exchange information. These business partners may be given limited access to company serves and access only to the data necessary to c onduct supply chain exchanges with the company.

### 3.10.2 Internet Architecture

The architecture of the Internet has also changed a great deal as it has grown explosively. Fig. 3.10.1 gives an overview of Internet architecture. We shall examine this figure piece by piece, starting with a computer at home (at the edges of the figure).

(a) To join the Internet, the computer is connected to an Internet Service Provider, or simply ISP, from whom the user purchases Internet access or connectivity. This lets the computer exchange packets with all of the other accessible hosts on the Internet. There are many kinds of Internet access, and they are usually distinguished by how much bandwidth they provide and how much they cost, but the most important attribute is connectivity.

(b) A common way to connect to an ISP is to use the phone line to our house, in which case our phone company is our ISP. ISP networks may be regional, national, or international in scope. However, there are several other popular ways to connect to an ISP.

- **DSL (Digital Subscriber Line)** reuses the telephone line that connects to our house for digital data transmission. The computer is connected to a device called a DSL modem that converts between digital packets and analog signals that can pass unhindered over the telephone line. DSL is a higher-bandwidth way to use the local telephone line than to send bits over a traditional telephone call instead of a voice conversation. That is called dial-up and done with a different kind of modem at both ends. The word modem is short for "modulator demodulator" and refers to any device that converts between digital bits and analog signals. At the other end, a device called a **DSLAM (Digital Subscriber Line Access Multiplexer)** converts between signals and packets.

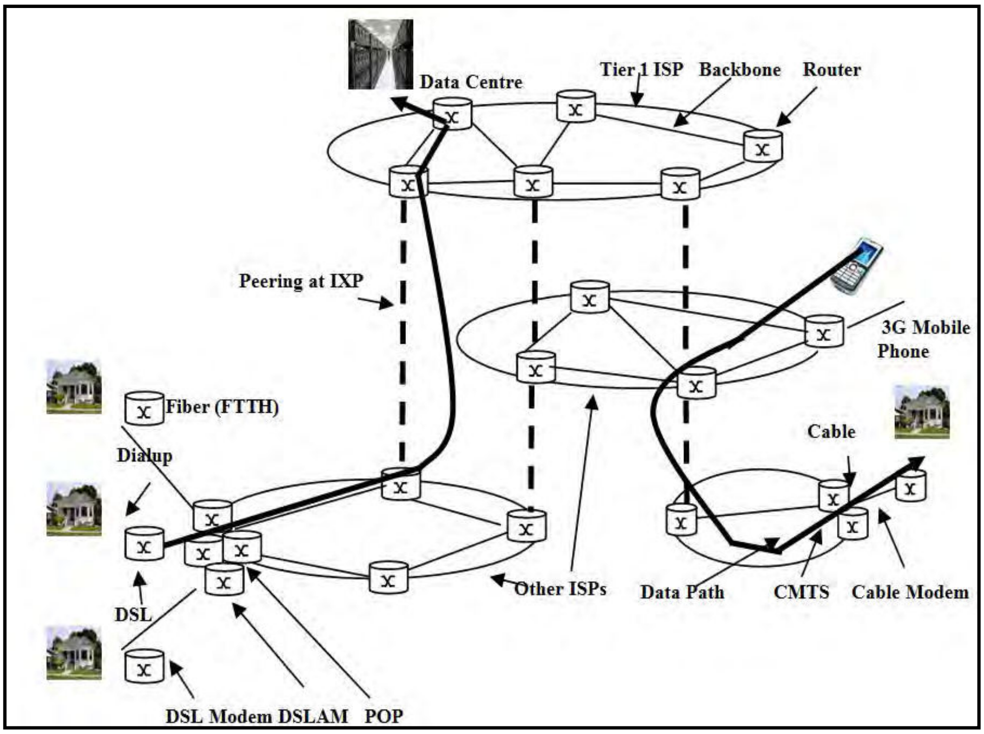



**Fig. 3.10.1: Overview of the Internet Architecture***

- Another method is to send signals over the cable TV system. Like DSL, this is a way to reuse existing infrastructure, in this case otherwise unused cable TV channels. The device at the home end is called a cable modem and the device at the cable head-end is called the **CMTS (Cable Modem Termination System)**.
- Wireless is used for Internet access for 3G mobile phone networks. They can provide data delivery at rates of 1 Mbps or higher to mobile phones and fixed

* Tanenbaum and Wetherall, 'Computer Networks', Fifth Edition, Prentice Hall, 2001, Page No. 62

subscribers in the coverage area. We call the location at which customer packets enter the ISP network for service the ISP's **POP (Point of Presence)**. Packets are moved between the POPs of different ISPs. From this point on, the system is fullydigital and packet switched.

(c) Internet Service Provider's architecture is made up of long-distance transmission lines that interconnect routers at POPs in the different cities that the ISPs serve. This equipment is called the backbone of the ISP. If a packet is destined for a host served directly by the ISP, that packet is routed over the backbone and delivered to the host. Otherwise, it must be handed over to another ISP.

(d) ISPs connect their networks to exchange traffic at IXPs (Internet eXchange Points). The connected ISPs are said to peer with each other. There are many IXPs in cities around the world. They are drawn vertically in the figure because ISP networks overlap geographically. Basically, an IXP is a room full of routers, at least one per ISP. A LAN in the room connects all the routers, so packets can be forwarded from any ISP backbone to any other ISP backbone. IXPs can be large and independently owned facilities.

(e) The peering that happens at IXPs depends on the business relationships between ISPs. There are many possible relationships. For example, a small ISP might pay a larger ISP for Internet connectivity to reach distant hosts, much as a customer purchases service from an Internet provider.

(f) The path a packet takes through the Internet depends on the peering choices of the ISPs. If the ISP delivering a packet peers with the destination ISP, it might deliver the packet directly to its peer. Otherwise, it might route the packet to the nearest place at which it connects to a paid transit provider so that provider can deliver the packet. Two example paths across ISPs are drawn in the figure.

(g) Often, the path a packet takes will not be the shortest path through the Internet. At the top of the food chain are a small handful of companies that operate large international backbone networks with thousands of routers connected by high-bandwidth fiber optic links. These ISPs do not pay for transit. They are usually called tier 1 ISPs and are said to form the backbone of the Internet, since everyone else must connect to them to be able to reach the entire Internet.

Companies that provide lots of content, such as Google and Yahoo!, locate their computers in data centers that are well connected to the rest of the Internet. These data centers are so large (tens or hundreds of thousands of machines) that electricity is a major cost, so data centers are sometimes built in areas where electricity is cheap.

### 3.10.3 Internet Applications

Internet can be used as a very effective media for various applications such as:

- E-mail, browsing the sites on the World Wide Web, and participating in special interest newsgroups are the most popular Internet applications.

- Electronic commerce transactions between businesses and their suppliers and customers can also performed with online web applications.
- The Internet provides electronic discussion forums and bulletin board systems formed and managed by thousands of special-interest newsgroups.
- Other applications include downloading software and information files and accessing databases provided by thousands of businesses, governments, and other organizations.
- The Internet allows holding real-time conversations with other Internet users.
- The Internet allows gathering information through online services using web browsers and search engines.
- Internet browser software enables millions of users to surf the World Wide Web by clicking their way to the multimedia information resources stored on the hyperlinked pages of businesses, government, and other websites.

### 3.10.4 Business Use of the Internet

Business uses of the Internet include the following:

- Strategic business alliances
- Providing customer and vendor support
- Collaboration among business partners
- Buying and selling products and services
- Marketing, sales, and customer service applications
- Growth of cross-functional business applications
- Emergence of a pplications in engineering, manufacturing, human resources and accounting.
- Enterprise communications and collaboration
- Attracting new customers with innovative marketing and products.
- Retaining present customers with improved customer service and support.
- Developing new web-based markets and distribution channels for existing products.
- Developing new information-based products accessible on the Web.
- Generating revenue through electronic commerce applications is a g rowing source of business value.
- Electronic commerce

### 3.10.5 Intranet

An **Intranet** is a network inside an organization that uses Internet technologies such as web browsers and servers, TCP/IP network protocols, HTML hypermedia document publishing and databases, and so on, to provide an Internet-like environment within the enterprise for information sharing, communications, collaboration, and the support of business processes.

An Intranet is protected by security measures such as passwords, encryption, and firewalls, and thus can be accessed by authorized users through the Internet. A Company's Intranet can also be accessed through the Intranets of customers, suppliers, and other business partners via extranet links. Refer to the Fig. 3.10.2.

- **The Business Value of Intranets:** Intranet applications support communications and collaboration, business operations and management, web publishing, and Intranet management. These applications can be integrated with existing IS resources and Applications, and extended to customers, suppliers, and business partners.
- **Communications and Collaboration:** Intranets can significantly improve communications and collaboration within an enterprise. Examples include:
  - Using an Intranet browser and workstation to send and receive e-mail, voicemail, paging, and fax to communicate with others within the organization, and externally through the Internet and extranets.
  - Using Intranet groupware features to improve team and project collaboration with services such as discussion groups, chat rooms, and audio and videoconferencing.

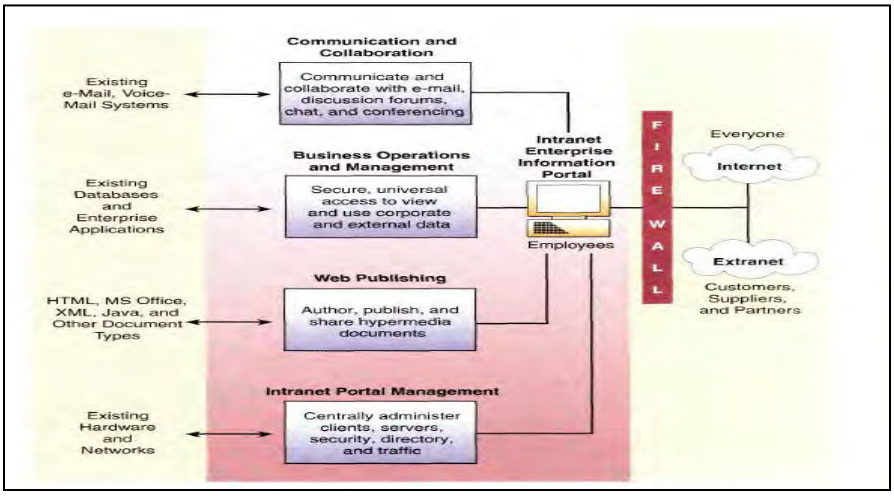



**Fig. 3.10.2: Role of Intranet in any organization***

* "Introduction to Information Systems" by James O'Brien, George M. Marakas, 11th edition, McGraw Hill

- **Web Publishing:** The advantages of developing and publishing hyperlinked multimedia documents to hypermedia databases accessible on World Wide Web servers has moved to corporate intranets. The comparative ease, attractiveness, and lower cost of publishing and accessing multimedia business information internally via intranet web sites have been one of the primary reasons for the explosive growth of the use of intranets in business. Publishing of various information products such as company's newsletters, technical drawings, product catalogs in variety of ways including hypermedia, web pages, e-mail and net broadcasting etc.
- **Business Operations and Management:** Intranets are being used as the platform for developing and deploying critical business applications to support business operations and managerial decision making across the internetworked enterprise. Examples include:
  - Many companies are developing customer applications like order processing, inventory control, sales management, and executive information systems that can be implemented on intranets, extranets, and the Internet.
  - Many applications are designed to interface with, and access, existing company databases and legacy systems. The software for such business uses, is then installed on Intranet web servers.
  - Employees within a company, or external business partners, can access and run applications using web browsers from anywhere on the network whenever needed.
  - Company newsletters, technical drawings, and product catalogs can be published in a variety of ways including hypermedia and web pages, e-mail, net broadcasting, and as part of in-house business applications.
  - Intranet software browsers, servers, and search engines can help to easily navigate and locate the business information.

### 3.10.6 Extranets

Extranets are network links that use Internet technologies to interconnect the Intranet of a business with the Intranets of its customers, suppliers, or other business partners. Companies can use Extranets to perform following functions:

- Establish direct private network links between themselves, or create private secure Internet links between them called virtual private networks.
- Use the unsecured Internet as the extranet link between its intranet and consumers and others, but rely on encryption of sensitive data and its own firewall systems to provide adequate security.

**Business Value of Extranets**

The business value of extranets is derived from several factors:

- The web browser technology of extranets makes customer and supplier access of intranet resources a lot easier and faster than previous business methods.

- Extranets enable a company to offer new kinds of interactive Web-enabled services to their business partners. Thus, extranets are another way that a business can build and strengthen strategic relationships with its customers and suppliers.
- Extranets enable and improve collaboration by a business with its customers and other business partners.
- Extranets facilitate an online, interactive product development, marketing, and customer-focused process that can bring better designed products to market faster.

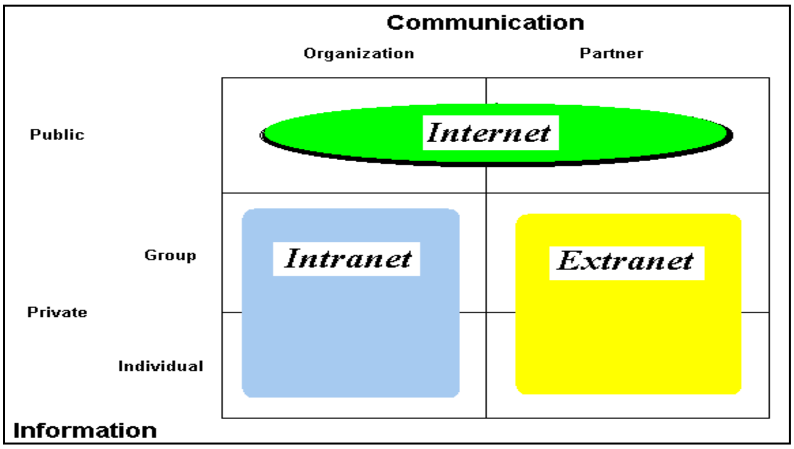



**Fig. 3.10.3: Relationship between the Internet, Intranet and Extranet**

An organization uses the Internet to communicate public information about itself to members of the organization and to others outside the organization. Referring to the Fig. 3.10.3, Intranets and Extranets are private versions of the Internet. An organization uses an intranet to share information between the members of the organization. Organizations use extranets to exchange information with and provide services to their business partners (customers, suppliers, etc.)

An extranet requires security and privacy that require firewall server management, the issuance and use of digital certificates or similar means of user authentication, encryption of messages, and the use of Virtual Private Networks (VPN) that tunnel through the public network.

Companies can use an extranet to do the following tasks:

- Share product catalogs exclusively with wholesalers or those "in the trade";
- Collaborate with other companies on joint development efforts;
- Jointly develop and use training programs with other companies;
- Provide or access services provided by one company to a group of other companies; and
- Share news of common interest exclusively with partner companies.

With competitive advantage as the ultimate prize, two fundamental drivers are propelling large enterprises to the extranet: market consolidation and service externalization. Markets are consolidating as the pace of merger, investment, and acquisition intensifies. Yet within companies, core services are also increasingly being externalized, delivered by a network of external parties that includes outsourcers, demand and supply chain partners, consultants, and contractors. This dynamic environment presents clear business needs, which can be summarized as the Five Rules of the Extranet which are as follows:

- **Be as flexible as the business:** An extranet must be driven by the demands of the market, not the limitations of technology. It must be extremely flexible and allow companies to immediately deploy extranet services that best fit the business need, be it intimate supply chain partners using a wide range of applications or mass e-commerce extranets driven by Web-based applications.
- **Deploy in "Internet time":** To deploy an extranet, companies shouldn't have to roll out a new infrastructure or go through a major re-architecting of their applications. To remain market-driven, enterprises must be able to deploy their extranet quickly, and leverage their existing infrastructure to do so.
- **Protect the interests of the data owner:** Extranet services need to be deployed in a fast and flexible way, but with the complete assurance that only the correct users can access the right services. An extranet must ensure that what's supposed to be private stays private.
- **Serve the partner as a customer:** An extranet presents a very important and delicate balance: providing customer service to key partners (who might also be customers) in a competitive environment with mission-critical resources at risk. The final solution must be an extranet without compromise. Partners should never be required to change their security policies, networks, applications, and firewalls for the "good" of the extranet community.
- **Drive information to the decision-maker:** An extranet must provide a central means to measure progress, performance, and popularity. Business units deploying applications need to understand which extranet content and applications are most successful.

### 3.10.7 Information Systems and Telecommunication

Telecommunications give an organization the capability to move information rapidly between distant locations and to provide the ability for the employees, customers, and suppliers to collaborate from anywhere, combined with the capability to bring processing power to the point of the application. All of this offers firm important opportunities to restructure its business processes and to capture high competitive ground in the marketplace. Through telecommunications, this value may be:

(i) An increase in the efficiency of operations;

(ii) Improvements in the effectiveness of management; and

(iii) Innovations in the marketplace.

Telecommunications may provide these values through the following impacts:

(a) **Time compression** - Telecommunications enable a firm to transmit raw data and information quickly and accurately between remote sites.

(b) **Overcoming geographical dispersion** - Telecommunications enable an organization with geographically remote sites to function, to a degree, as though these sites were a single unit. The firm can then reap benefits of scale and scope which would otherwise be unobtainable.

(c) **Restructuring business relationships** - Telecommunications make it possible to create systems which restructure the interactions of people within a firm as well as a firm's relationships with its customers. Operational efficiency may be raised by eliminating intermediaries from various business processes.

## 3.11 Electronic Commerce

**Electronic Commerce (e-Commerce)** and its related technologies are unquestionably the current leading-edge business and finance delivery systems for the 21st Century. The explosion in the application of technologies and the delivery of these technologies into the hands of consumers has made the vision, the dream, the fantasy, of conducting business electronically, anywhere in the global community, a reality. Electronic Commerce (EC) is no longer just a concept; it is a market force to be reckoned with. As more and more organizations launch Internet/World Wide Web (WWW) home pages and intranets to disseminate company/product information, and expand their customer base, countless yet unnamed companies are just beginning to investigate this alternative. These companies are realizing that business via the Internet is inevitable that they will not be able to ignore. The lure of reaching additional customers, expanding market shares, providing value-added services, advancing technological presence, and increasing corporate profits is just too valuable to disregard, and will eventually attract companies to electronic commerce like moths to a flame.

Electronic Commerce is the process of doing business electronically. It refers to the use of technology to enhance the processing of commercial transactions between a company, its customers and its business partners. It involves the automation of a variety of business-to-business and business-to-consumer transactions through reliable and secure connections.

E-Commerce is a sophisticated combination of technologies and consumer-based services integrated to form a new paradigm in business transaction processing. The future of e-Commerce is bright and viable—the application, however, has not yet reached full integration into the business mainstream. Several significant hurdles remain, which must be cleared before electronic commerce will become a mainstay business strategy.

### 3.11.1 Benefits of e-Commerce Application and Implementation

E-Commerce presents immense benefits to individual organizations, consumers, and society as a whole.

- Reduction in costs to buyers from increased competition in procurement as more suppliers are able to compete in an electronically open marketplace.
- Reduction in errors, time, and overhead costs in information processing by eliminating requirements for re-entering data.
- Reduction in costs to suppliers by electronically accessing on-line databases of bid opportunities, on-line abilities to submit bids, and on-line review of rewards.
- Reduction in time to complete business transactions, particularly from delivery to payment.
- Creation of new markets through the ability to easily and cheaply reach potential customers.
- Easier entry into new markets, especially geographically remote markets, for enterprises regardless of size and location.
- Better quality of goods as specifications are standardized and competition is increased and improved variety of goods through expanded markets and the ability to produce customized goods.
- Faster time to market as business processes are linked, thus enabling seamless processing and eliminating time delays.
- Optimization of resource selection as businesses form cooperative teams to increase the chances of economic successes, and to provide the customer products and capabilities more exactly meeting the requirements.
- Reduction in inventories and reduction of risk of obsolete inventories as the demand for goods and services is electronically linked through just-in-time inventory and integrated manufacturing techniques.
- Reduction in overhead costs through uniformity, automation, and large-scale integration of management processes.
- Reduction in use of ecologically damaging materials through electronic coordination of activities and the movement of information rather than physical objects).
- Reduction in advertising costs.

Clearly, the benefits of corporate-wide implementation of e-Commerce are many, and this list is by no means complete. With the benefits, however, also come the risks. An organization should be cautious not to leap blindly into e-Commerce, but rather first develop an e-Commerce strategy, and then organize a corporate-wide team to implement that strategy.

### 3.11.2 Risks involved in e-Commerce

The risks associated with e-Commerce are multi-faceted. Given below is a sample listing of risks of e-Commerce:

- **Problem of anonymity:** There is need to identify and authenticate users in the virtual global market where anyone can sell to or buy from anyone, anything from anywhere.
- **Repudiation of contract:** There is possibility that the electronic transaction in the form of contract, sale order or purchase by the trading partner or customer may be denied.
- **Lack of authenticity of transactions:** The electronic documents that are produced in the course of an e-Commerce transaction may not be authentic and reliable.
- **Data Loss or theft or duplication:** The data transmitted over the Internet may be lost, duplicated, tampered with or replayed.
- **Attack from hackers:** Web servers used for e-Commerce may be vulnerable to hackers.
- **Denial of Service:** Service to customers may be denied due to non-availability of system as it may be affected by viruses, e-mail bombs and floods.
- **Non-recognition of electronic transactions:** e-Commerce transactions, as electronic records and digital signatures may not be recognized as evidence in courts of law.
- **Lack of audit trails:** Audit trails in e-Commerce system may be lacking and the logs may be incomplete, too voluminous or easily tampered with
- **Problem of piracy:** Intellectual property may not be adequately protected when such property is transacted through e-Commerce

### 3.11.3 Types of e-Commerce

There are four general classes of e-Commerce applications:

(a) Business-to-Business (B2B) e-Commerce

(b) Business-to-Consumer (B2C) e-Commerce

(c) Consumer-to-Business (C2B) e-Commerce

(d) Consumer-to-Consumer (C2C) e-Commerce

(e) Business-to-Government (B2G) e-Commerce

(f) Business-to-Employee (B2E) e-Commerce

**A. Business-to-Business (B2B) e-Commerce**

B2B refers to the exchange of services, information and/or products from one business to another. B2B electronic commerce typically takes the form of automated processes between trading partners and is performed in much higher volumes than Business-to-Consumer (B2C) applications. B2B can also encompass marketing activities between businesses, and not just the final transactions that result from marketing.

**B. Business-to-Consumer (B2C) e-Commerce**

It is defined as the exchange of services, information and/or products from a business to a consumer, as opposed to between one business and another. Typically, a B2C e-Commerce business has a virtual store front for consumers to purchase goods and services eliminating the need to physically view or pick up the merchandise.

The Business-to-Consumer (B2C) model can save time and money by doing business electronically but customers must be provided with safe and secure as well as easy-to-use and convenient options when it comes to paying for merchandise. This minimizes internal costs created by inefficient and ineffective supply chains and creates reduces end prices for the customers. This could be beneficial especially if we are in the business of commodity-like products where we must be innovative and accommodating to gain and retain customers.

Advantages of B2C E-Commerce include:

(i) Shopping can be faster and more convenient.

(ii) Offerings and prices can change instantaneously.

(iii) Call centers can be integrated with the website.

(iv) Broadband telecommunications will enhance the buying experience.

**C. Consumer-to-Business (C2B) e-Commerce**

In C2B e-Commerce model, consumers directly contact with business vendors by posting their project work online so that the needy companies review it and contact the consumer directly with bid. The consumer reviews all the bids and selects the company for further processing. Some examples are guru.com, rentacoder.com, getacoder.com, freelancer.com.

**D. Consumer-to-Consumer (C2C) e-Commerce**

C2C e-Commerce is an Internet-facilitated form of commerce that has existed for the span of history in the form of barter, flea markets, swap meets, yard sales and the like. C2C e-Commerce sites provide a virtual environment in which consumers can sell to one another through a third-party intermediary.

**E. Business-to-Government (B2G) e-Commerce**

B2G e-Commerce, also known as e-Government, refers to the use of information and communication technologies to build and strengthen relationships between government and employees, citizens, businesses, non-profit organizations, and other government agencies.

**F. Business-to-Employee (B2E) e-Commerce**

B2E e-Commerce, from an intra-organizational perspective, has provided the means for a business to offer online products and services to its employees.

### 3.11.4 Key aspects to be considered in implementing e-Commerce

Successful implementation of e -Commerce requires involvement of key stakeholders and should ideally include representatives from: accounting/ finance, internal audit, IT security, telecommunications, end users, system analysts, and legal. Further, key trading partners, external auditors, and representatives from other institutions such as banks, trading houses, brokers, and other third-party services should also be involved to obtain valuable insight into the design and deployment of the e-Commerce solution. Other key aspects to be considered are as follows:

- Implementing appropriate policies, standards and guidelines
- Performing cost benefit analysis and risk assessment to ensure value delivery
- Implementing the right level of security across all layers and processes
- Establishing and implementing the right level of baseline (best practice) controls
- Integration of e-Commerce with the business process and the physical delivery channels
- Providing adequate user training
- Performing post implementation review to ensure controls are working as envisaged.

## 3.12 Mobile Commerce

**Mobile Commerce or m-Commerce**, is about the explosion of applications and services that are becoming accessible from Internet-enabled mobile devices. It involves new technologies, services and business models. It is quite different from traditional e-Commerce. Mobile phones or PDAs impose very different constraints than desktop computers. But they also open the door to a slew of new applications and services.

M-commerce (mobile commerce) is the buying and selling of goods and services through wireless handheld devices such as cellular telephone and personal digital assistants (PDAs) Known as next-generation e-commerce, m-commerce enables users to access the Internet without needing to find a place to plug in. The emerging technology behind m-commerce, which is based on the Wireless Application Protocol (WAP), has made strides in countries, where mobile devices equipped with Web-ready micro-browsers are much more common.

As content delivery over wireless devices becomes faster, more secure, and scalable, there is wide speculation that m-commerce will surpass wire-line e-commerce as the method of choice for digital commerce transactions. The industries affected by m-commerce include:

- Financial services, which includes mobile banking (when customers use their handheld devices to access their accounts and pay their bills) as well as brokerage services, in which stock quotes can be displayed and trading conducted from the same handheld device.
- Telecommunications, in which service changes, bill payment and account reviews can all be conducted from the same handheld device.

- Service/retail, as consumers are given the ability to place and pay for orders on-the-fly.
- Information services, which include the delivery of financial news, sports figures and traffic updates to a single mobile device.

## 3.13 Electronic Fund Transfer

**Electronic Funds Transfer (EFT)** represents the way the business can receive direct deposit of all payments from the financial institution to the company bank account. Once the user Signs Up, Money Comes to him directly and sooner than ever before. EFT is fast, safe, and means that the money will be confirmed in user's bank account quicker than if he had to wait for the mail, deposit the cheque, and wait for the funds to become available.

The payment mechanism moves money between accounts in a fast, paperless way. These are some examples of EFT systems in operation:

- **Automated Teller Machines (ATMs):** Consumers can do their banking without the assistance of a teller, or to make deposits, pay bills, or transfer funds from one account to another electronically. These machines are used with a debit or EFT card and a code, which is often called a personal identification number or "PIN."
- **Point-of-Sale (PoS) Transactions:** Some debit or EFT cards (sometimes referred to as check cards) can be used when shopping to allow the transfer of funds from the consumer's account to the merchant's. To pay for a purchase, the consumer presents an EFT card instead of a cheque or cash. Money is taken out of the consumer's account and put into the merchant's account electronically.
- **Preauthorized Transfers:** This is a method of automatically depositing to or withdrawing funds from an individual's account, when the account holder authorizes the bank or a third party (such as an employer) to do so. For example, consumers can authorize direct electronic deposit of wages, social security, or dividend payments to their accounts. Or they can authorize financial institutions to make regular, ongoing payments of insurance, mortgage, utility, or other bills.
- **Telephone Transfers:** Consumers can transfer funds from one account to another through telephone instructions rather than traditional written authorization or instrument. The accounts being debited can be checking or savings, for example—or can order payment of specific bills by phone.

## 3.14 Summary

Before wires and virtual networks transmitted communications, there were smoke signals, drums and carrier pigeons. Fortunately, technology has come a long way since then to the point where it's impossible to overemphasize the significance of telecommunications technology to any business, especially as it relates to growing the capacity of small businesses. From telephones, facsimile, television, Internet and the vast array of private networks, telecommunications technology has become firm's central nervous system. Without it, a small business couldn't compete or survive in the nation's information service-dependent economy, making it one of the most important investments we will make as we build our business.

Telecommunication is an important tool for businesses. It enables companies to communicate effectively with customers and deliver high standards of customer service. Telecommunication is also a key element in teamwork, allowing employees to collaborate easily from wherever they are located. Mobile telecommunication gives companies the opportunity to introduce more flexible working by allowing employees to work efficiently from home. The introduction of Internet gives employees new levels of productivity and capability on the move.

# 4

# Business Information Systems

| Learning Objectives |
|---|
| ♦ To define key terms such as business processes, information systems as they relate to Business Information System (BIS); |
| ♦ To introduce the concept and components of BIS; |
| ♦ To understand the relationship between organizations, business processes and the information systems used in their day-to-day activities; |
| ♦ To recognize how the organizations and information systems integration facilitate business processes |
| ♦ To make out how IT works as a business enabler & driver with the help of various information systems; |
| ♦ To discuss all levels of information systems and the various types such as TPS, OAS, KMS, MIS, DSS, ESS etc at each level; |
| ♦ To define the specialized systems such as ERP, CRM, SCM, HRMS, Core Banking System and Accounting Information systems and their working and usage; |
| ♦ To elaborate the concept of Artificial Intelligence, Expert systems, and Business Intelligence; |
| ♦ To have a bird-eye view on Business Reporting tools; |
| ♦ To have an overview of Access controls in any organization and different modes of payment mechanism; and |
| ♦ To widespread the range of applications of BIS systems in business, industry, government, academia and other burgeoning field. |
| **Task Statements** |
| ♦ To implement various information systems in perspective of any business organization; |
| ♦ To check how the Artificial intelligence and Expert Systems work in different application areas; |
| ♦ To check how the Information Systems act as a business enabler and driver; |

- To assess the effectiveness of Information Systems like DSS, MIS, OAS etc. and results in better management of business processes;
- To know how the right information transported to the right person, in the right fashion, and at the right time is applied through business intelligence for appraising business performance;
- To assess how ERP has also evolved considerably with computer and technological advances;
- To understand how ERP software facilitates competent and efficient administration, and mechanized business activities; and
- To understand how CRM establishes the benefits of generating customer loyalty, raising a market intelligence enterprise.

**Knowledge Statements**

- To know how IT optimizes a company's important core business processes;
- To know modern information technology facilitate the functions of various company divisions and create transparency in the process;
- To know how Management Information system is an integrated, user- machine system for providing information to support operation, management and decision-making functions in an organization;
- To know how DSS leads to knowledge, this leads to new demands, and the modification of the system;
- To know how ERP systems integrate internal and external management information across an entire organization; and
- To recognize how AIS is a system that brings data together, records, stores, and processes it to fabricate information for decision makers.

## 4.1 Introduction

**Business Information Systems** known for its acronym BIS is a burgeoning term in a corporate world and academia too. In the present scenario, when only thing constant in the world is 'change'; BIS is a preferred software engine for the development of Information Technology (IT) in most recent years. This chapter discusses in length about BIS, its application and its impact on organizations. It also throws a light on various 3 letter acronyms which had revamped the IT Integration with management and created a benchmark in a business era. This analysis and framework of BIS gives readers a solid introduction to BIS and provide them a platform to explore the application perspectives

The world of commerce, business and trade as we know is speedily changing and term **'e'** is adding as a prefix in order to add a feather in a cap. Globalization has become embedded, trade and finance are hot-blooded, customers are more demanding and competition has purely augmented greater than before. There was a time when the things were supplier centric; but thanks to paradigm shift which is moving towards an era of customer centric approach where the customer is an ultimate key man in deciding and IT seems to be a driving force rather only an enabler. Organizations have gradually further turned to business linked with technology and more adopting out-of-box approach to aid triumph against the challenges of the 21st Century.

We need to understand how diverse Information systems and specialized systems are essential to augment the performance of any organization.

## 4.2 Information Technology as a Key Business Enabler & Driver

Information is said to be the currency of the present business environment and rightfully it can be said that we are living in the 'Information Age'. Information is a significant resource to an organization. It represents the organization's tangible and intangible resources and all transactions relating to those resources. Information influences the way an organization operates. The right information, if it is transported to the right person, in the right fashion, and at the right time, can progress and guarantee organizational effectiveness and competence. The BIS is the mechanism used to manage and control the information resource.

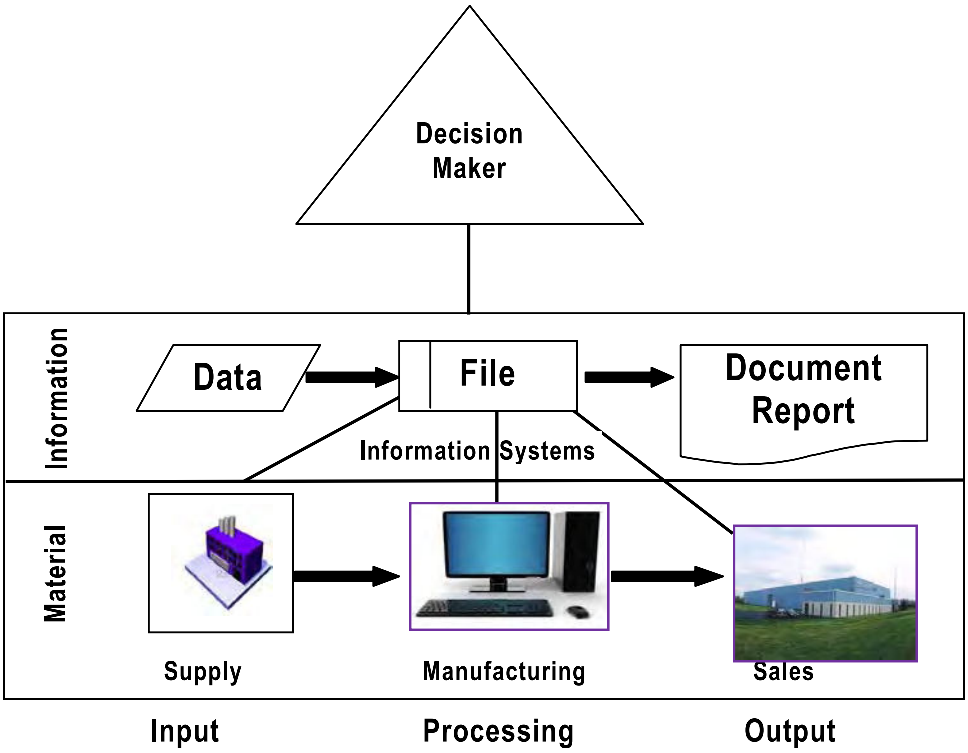



Fig. 4.2.1: Information System as an enabler to convert Input into Output

Thus it is apparent from the above Fig. 4.2.1 as to how Information System facilitates in converting input into output. An Information System is an integrated process of components for collecting, storing, processing, and communicating information. Any specific Information System aims to support operations, management and decision making.

Information Systems (IS) refers to the interface of people, processes, and technology as shown in the Fig. 4.2.2.

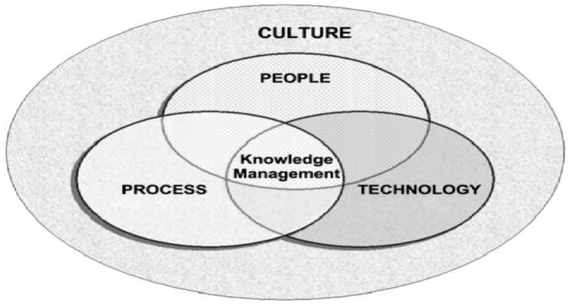



**Fig. 4.2.2: Integration of People, Process and Technology a Three Tier Approach**

If we see the three terms PPT which is known for its acronym; **People, Process and Technology (PPT)** is a very important aspect. People need technology to process the information in fast and accurate manner with a motive to get an edge, which is very well depict and self-explanatory in nature. Here People are considered as a Frontline Employees, executives and managers. The role of information systems in the organization is shifting to support business processes rather than individual functions. The focus is outwards to customers, rather than inwards to procedures.

Information Technology or Information System is used inter-changeably in place of each other. However, Information System is a broader term including information technologies as relevant and required. It is noticeable that Information Systems are dissimilar from Information Technology in that an Information System has an Information Technology section that interacts with the people and procedure components.

As already explained, **'IT'** is an exceptionally imperative and acquiescent resource offered to organizations. As information systems have facilitated supplementary varied human activities, they have put forth a thoughtful power over civilization. These systems have impacted the pace of growth of day-to-day activities, expanded the scope of service offerings and empowered enterprises to reach out to customers across the world without the limitations of time and space.

People require information for many reasons and in varied ways. For example, we probably seek information for entertainment and enlightenment by viewing television, watching movies, browsing the Internet, listening to the radio, and reading newspapers, magazines, and books. In business, however, people and organizations seek and use information specifically to make sound decisions and to solve problems - two closely related practices that form the foundation of every successful company.

## 4.3 Information Systems

*A detailed discussion on "Information Systems' Layers" and "Information Systems Life Cycle" has already been introduced in Chapter – 2 "Information Systems and IT Fundamentals" of the Study Material of Intermediate (IPC) Course. However, a detailed discussion on "Information Systems" is provided below.*

Let us understand the related terms.

**Information:** First of all, we should be able to distinguish between Data and Information. Data is a raw fact and can take the form of a number or statement such as a date or a measurement. It is necessary for businesses to put in place procedures to ensure data have been processed so that they are meaningful. This requires a process that is used to produce information which involves collecting data and then subjecting them to a transformation process in order to create information. Some examples of information include aggregating which summarizes data by such means as taking an average value of a group of numbers. Sorting organizes data so that items are placed in a particular order, for example listing orders by delivery date etc.

**System:** The system can be defined as "a group of mutually related, cooperating elements with a defined boundary; working on reaching a common goal by taking inputs and producing outputs in organized transformation process."

Not every system has a single goal and often a system contains several subsystems with sub goals, all contributing to meeting the overall system goal. For example the finance, operations and marketing areas of an organization should all have goals which together help to achieve overall corporate objectives. In systems, data are used as the input for a process that creates information as an output. In order to monitor the performance of the system, some kind of feedback mechanism is required. In addition, control must be exerted to correct any problems that occur and ensure that the system is fulfilling its purpose. There are thus five components of a generic system in terms of **Input, Process, Output, Feedback** and **Control**.

In the extensive sense, the term Information Systems (IS) refers to the interaction between processes and technology.

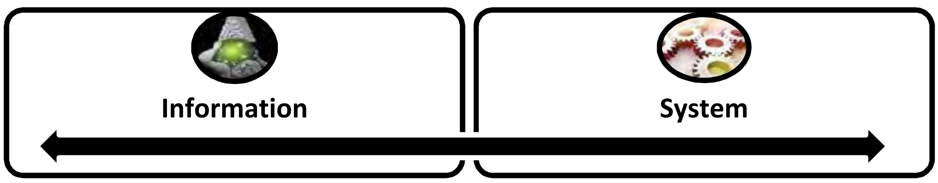



**Fig. 4.3.1: Bifurcation of a Terminology 'Information' and 'System'**

From the Fig. 4.3.1, we can see how Information and System are interlinked with one another.

**Information System:** Information System (IS) is a combination of people, hardware, software, communication devices, network and data resources that processes (can be storing, retrieving, transforming information) data and information for a specific purpose. The system needs inputs from user (key in instructions and commands, typing, scanning) which will then be processed (calculating, reporting) using technology devices such as computers, and produce output (printing reports, displaying results) that will be sent to another user or other system via a network and a feedback method that controls the operation.

In general, any specific Information System aims to support operations, management and decision-making.

### 4.3.1 Components of Information System

The main aim and purpose of each Information System is to convert the data into information which is useful and meaningful. An Information System depends on the resources of people (end users and IS specialists), hardware (machines and media), software (programs and procedures), data (data and knowledge bases), and networks (communications media and network support) to perform input, processing, output, storage, and control activities that transform data resources into information products. This information system model highlights the relationships among the components and activities of information systems. It also provides a framework that emphasizes four major concepts that can be applied to all types of information systems:

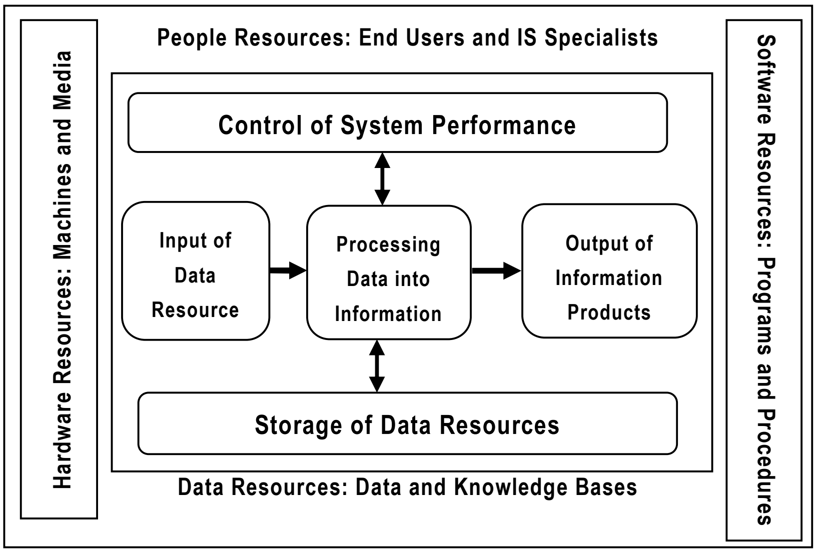



**Fig. 4.3.2: Components of Information System***

* "Introduction to Information Systems" by James O'Brien, George M. Marakas, 11th edition, McGraw Hill, Page No. 31

Fig. 4.3.2 illustrates an Information System Model that expresses a fundamental conceptual framework for the major components and activities of Information systems.

(i) **People**, **Hardware**, **Software**, **Data** and **Networks** are the five basic resources of information systems;

(ii) **People Resources** consist of end users and IT specialists; **Hardware resources** involve machines and media; **Software resources** include programs and procedures; **Data resources** include data and knowledge bases; and **Network resources** include communications media and networks;

(iii) **Data Resources** are transformed by information processing activities into a variety of information products for end users; and

(iv) Information processing consists of the system activities of input, processing, output, storage, and control.

All components of Information Systems are mutually connected and cannot exist individually. The relationship between separated components is defined for best process efficiency.

**Table 4.3.1: Information Systems Resources and Products**

| | |
|---|---|
| **People Resources** | Specialists - systems analysts, software developers, systems operators<br>End Users—anyone else who uses information systems |
| **Hardware Resources** | Machines - computers, video monitors, magnetic disk drives, printers, optical scanners.<br>Media - floppy disks, magnetic tape, optical disks, plastic cards, paper forms. |
| **Software Resources** | Programs - operating system programs, spreadsheet programs, word processing programs, payroll programs.<br>Procedures - data entry procedures, error correction procedures, paycheck distribution procedures. |
| **Data Resources** | Product descriptions, customer records, employee files, inventory databases. |
| **Network Resources** | Communications media, communications processors, network access, control software. |
| **Information Products** | Management reports and business documents using text and graphics displays, audio responses, and paper forms. |

Table 4.3.1 illustrates Information System Resources and their corresponding Products.

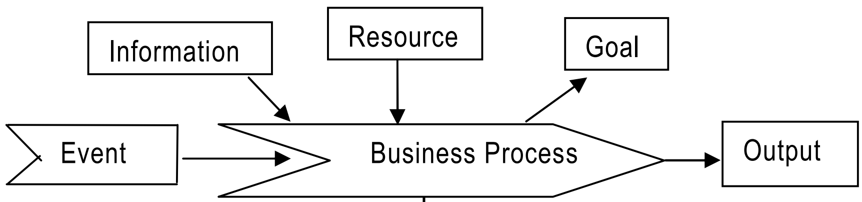
During Information processing; Input can be data, information and instructions; Processing may involve calculations, programming and storing; Output could be in terms of Print-outs, Reports, Graphics; and Controls could be related to decision-making and the feedback.

**Business Information System:** Business Information Systems (BIS) may be defined as systems integrating information technology, people and business. BIS bring business functions and information modules together for establishing effective communication channels which are useful for making timely and accurate decisions and in turn contribute to organizational productivity and competitiveness.

In this entire chapter, we will throw light on distinguished type of systems mentioned above in a structure which finally furnishes a shape to a gigantic system known as Business Information System.

## 4.4 Organizations, Information Systems and Business Processes

**Business Process:** A business process is an activity or set of activities that will accomplish a specific organization goal.




A business process:

i. Has a Goal
ii. Has specific inputs
iii. Has specific outputs
iv. Uses resources
v. Has a number of activities that are performed in some order
vi. May affect more than one organizational unit. Horizontal organizational impact.
vii. Creates value of some kind for the customer. The customer may be internal or external.

**Fig. 4.4.1: Business Process Model**

Referring to the Fig. 4.4.1, we can say that a business process is a collection of activities intended to produce an explicit output for a particular customer or market. It implies a strong prominence on how the work is done within an organization, in contrast to a product's focus on what. A process is thus a specific ordering of work activities across time and place, with a beginning, an end, and clearly defined inputs and outputs: a structure for action.

Information Technology, which was for a long time considered an enabler of an organization's approach, is currently viewed as a vital ingredient of an organization's strategy in using information to take advantage of opportunities and encourage organizational growth. IT has progressed from being a separate function, marginalized from the rest of the organization, to a critical function in an organization. Any endeavor in an organization, now requires considerable information inputs, and this has made it vital for organizations to replace old systems.

To be successful in today’s highly ready for action world; one has to be able to visualize the future. The key to managing opportunities lies in one's ability to, in actual fact; manage the large amount of information available. In order to deliver high quality information to the decision makers at the right time and also to computerize the process of data collection, collation and refinement it is essential to bring into play information technology especially BIS to its full potential and in the best possible way.

For the last decade and a half, the business community has seen what appears to be one fashion after another. To a surprising (and to a great extent under-recognized) degree, nonetheless, these enthusiasms are facets and constitutes of one major theme – the significance of information and its competent use to the accomplishment of the modern corporation. If we go into the diverse approaches to Information System keeping into consideration, BIS is a key component of a system in enterprise. The components which earlier used to be standalone are now effectual combined into information systems through IT. With the help of Information System, businesses are able to process and operate its daily works more accurate and easier.

In order to be able to compete successfully in the modern business environment, information systems must be able to:

- have large capacity for storage of information and also provide faster access;
- provide support for decision making;
- grant a competitive edge;
- ensure fast and accurate processing of data and make it available as and when required;
- offer faster communication and exchange of information across the value chain;
- reduce information redundancy;

## 4.5 Information Systems and their role in Businesses

Enhancing the effectiveness of information systems always results in better management of business processes. When companies have skill-full business processes, they can be much more successful and competitive in the marketplace. In today’s aggressive business environment, companies compete on how they can provide to their existing and future customers goods and services more promptly and cheaper than their competitors. This is accomplished by well-organized, integrated information systems. It is superior to appreciate on how Information Systems process data and facilitate decision-making before discussing their different types distinctly.

Many business organizations obtain a competitive advantage by employing new information systems. The history of information systems goes back merely five decades, but from its inception, IS has done more to expand business and industry into global markets than any other technology. The backbone of 'IS' is the World Wide Web, Internet, or within a business a Local Area Network (LAN), along with EDI, EIS, ERP, SCM, eCRM, E-commerce and host of others, which portray new ways in which IS can be employed to cultivate business.

In the beginning stages, utilization of IS was merely on routine job and task centric, later on it become information centric i.e. integration of subsystems, afterwards user centric pedagogy formulated which includes office automation and DSS, then after Customer centric approach such as customer relationship management, strategic application came into force, then after service orientation came into existence which talks about total cost of ownership.

## 4.6 Types of Information Systems

We will see the detail implementations of all those managerial aspects gradually in the following Fig. 4.6.1. The figure shows how IS can support the four level of decisions which revolves around **Strategy**, **Management, Knowledge** and **Operations**.

The Figure also throws a light on typical structure of IS in an organization perspectives. If we see the figure from the top there are three hierarchies. The Upper hierarchy is totally focused on Strategic and planning issues whereas Middle hierarchy entirely concentrate on management, control of process, collaboration, knowledge and Office automation under the supervision of human resource. At last the lower level, which exclusively inclined to operations that talks about Transaction Processing System.

- **Strategic-Level Systems:** For strategic managers to track and deal with strategic issues, assisting long-range planning. A principle area is tracking changes in the external conditions (market sector, employment levels, share prices, *etc*.) and matching these with the internal conditions of the organization.
- **Management-Level Systems:** Used for the monitoring, controlling, decision-making, and administrative activities of middles management. Some of these systems deal with predictions or "what if…" type questions. e.g. "What would happen to our profits if the completion of the new production plant was delayed by 6 months?" Tracking current progress in accord with plans is another major function of systems at this level.
- **Knowledge-Level Systems:** These systems support discovery, processing and storage of knowledge and data workers. These further control the flow of paper work and enable group working.
- **Operational-Level Systems:** Support operational managers tracking elementary activities. These can include tracking customer orders, invoice tracking, etc. Operational-level systems ensure that business procedures are followed.

### Who uses Information Systems?

As depicted in the Fig. 4.6.1, the groups served at different levels are as follows:

- **Strategic Level:** These are senior managers or Top-level managers that hold the titles such as Chief Executive Officers, Chief Financial Officers, Chief Operational Officers, Chief Information Officers and Chair Person of the Board, President, Vice President and Corporate Head Managers take decisions that will affect the entirety of the organization. Top Managers do not direct the day-to-day activities of the firm; rather they set goals for the organization and direct the company to achieve them. Top Managers are ultimately responsible for the performance of the organization, and often, these managers have very visible jobs.

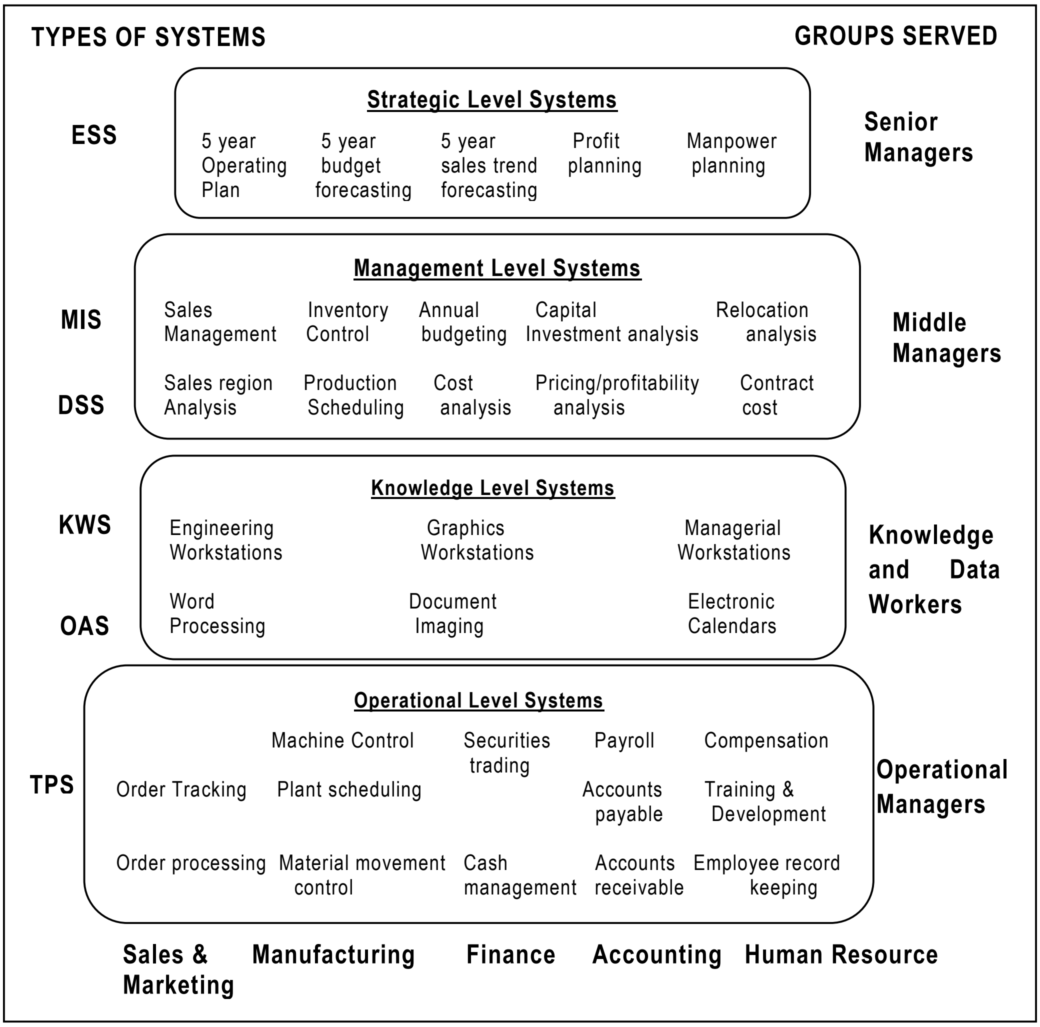



**Fig. 4.6.1: Types of Information Systems and the Groups Served**

- **Management Level:** These are Middle Managers that are in the levels below top managers and hold the job titles like General Manager, Regional manager etc. Middle-level Managers are responsible for carrying out the goals set by Top Management. They do so by setting goals for their department and other business units. Middle Managers can motivate and assist First-line Managers achieve business objectives. Middle Managers may also communicate upwards, by offering suggestions and feedback to Top Managers. Because Middle Managers are more involved in the day-to-day workings of a company, they may provide valuable information to Top Managers to help improve the performance of an organization.

- **Knowledge Level:** These include knowledge and data workers who are selected, recruited and trained in a special manner than the non-knowledge workers. The knowledge resides in the heads of knowledge workers and these are the most precious resource an organization possesses.
- **Operational Level:** These include Operational Managers or supervisors that are responsible for the daily management of the line workers who actually produce the product or offer the service. There are First-line Managers in every work unit in the organization. Although First-line Managers typically do not set goals for the organization, they have a very strong influence on the company. These are the managers that most employees interact with on a daily basis, and if the managers perform poorly, employees may also perform poorly, may lack motivation, or may leave the company.

### 4.6.1 Transaction Processing System (TPS)

The detonation of e-business and Web-based commerce, which we in general call E-commerce and the long-lasting expansion of the global economy, are placing ever-greater demands on transaction processing systems. For example, travel reservation systems that some time ago maintained solitary by travel professionals is at the present in a straight line reachable by anybody with an Internet connection and a Web browser. Transaction Processing Systems were the elite domain of mainframe computers.

A **Transaction Processing System (TPS)** may be defined as a type of information system that collects, stores, modifies and retrieves the day-to-day data transactions of an enterprise. Archetypal examples of such systems would be used in an Airline Reservation Systems, Railway reservation System, Banking Systems, or the Accounting System of roughly any outsized company. Fig. 4.6.2 illustrates a typical Transaction Processing Cycle.

(i) **Data Entry:** The first step of the transaction processing cycle is the capture of business data. For example, transaction data may be collected by point-of-sale terminals using optical scanning of bar codes and credit card readers at a retail store or other business. The recording and editing of data has to be quickly and correctly captured for its proper processing.

(ii) **Transaction Processing:** Transaction processing systems process data in two basic ways: (i) batch processing, where transaction data are accumulated over a period of time and processed periodically, and (ii) real-time processing (also called online processing), where data are processed immediately after a transaction occurs. All online TPS depend on the capabilities of fault tolerant computer systems that can continue to operate even if parts of the system fail and incorporate real-time processing capabilities.

(iii) **Database Maintenance:** An organization's databases must be updated by its transaction processing systems so that they are always correct and up-to-date. For example, database maintenance ensures that these and other changes are reflected in the data records stored in the company's databases.

(iv) **Document and Report Generation:** Transaction Processing Systems produce a variety of documents and reports. Examples of transaction documents include purchase orders, paychecks, sales receipts, invoices, and customer statements.

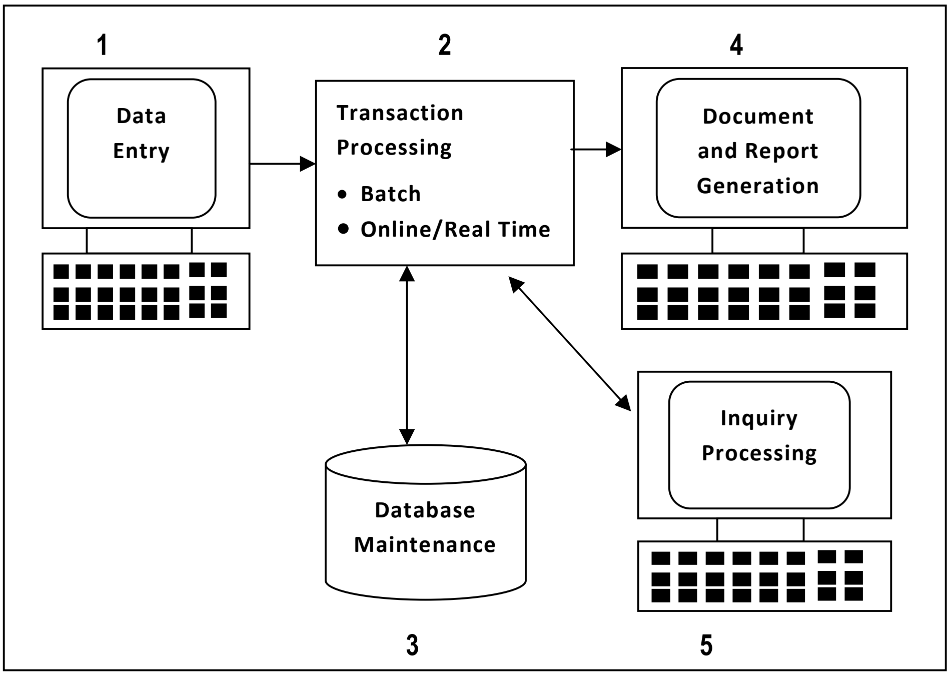



**Fig. 4.6.2: Transaction Processing Cycle***

TPS systems are designed to process transactions virtually instantly to ensure that customer data is available to the processes that require it. Most of the Transaction Processing Systems include one or additional of the following attributes as detailed in Table 4.6.1.

**Table 4.6.1: TPS Attributes**

| | |
|---|---|
| **Access Control -** | Most Transaction Processing Systems come with access control to put a ceiling on users to only those allowed to accomplish so. |

* "Introduction to Information Systems" by James O'Brien, George M. Marakas, 11th edition, McGraw Hill, Page No. 280

| | |
|---|---|
| **TPS** | Access Control ensures that people who are not authorized to use the system are not permissible to influence or transform the transaction process. |
| **Equivalence - TPS** | Transactions are processed in the similar format every time to ensure that full effectiveness is achieved. The TPS Interfaces are designed to get hold of identical data for each transaction, despite the consequences of the source. |
| **High Volume Rapid Processing - TPS** | In most of the transaction processing, the foremost issue is momentum. The instantaneous processing of transactions is noteworthy to the success of certain industry such as banking. TPS is designed to process transactions in an immediate effect to make confident that the transaction data is available to other users or processes that entail it. |
| **Trustworthiness - TPS** | A TPS system is designed to be robust and trustworthy. The system is capable to process transactions very rapidly, yet at the same time, conduct several checks to make certain that the data integrity is preserved. |

**Transactions Processing Qualifiers:** In order to qualify as a TPS, transactions made by the system must pass the **ACID Test**. The **ACID Test** refers to the following four prerequisites as discussed in the Table 4.6.2:

**Table 4.6.2: Pre-requisites of ACID TEST for any TPS**

| Prerequisite | Explanation |
|---|---|
| **Atomicity** | This means that a transaction is either completed in full or not at all. TPS systems ensure that transactions take place in their entirety. For example, if funds are transferred from one account to another, this only counts as a bona-fide transaction if both the withdrawal and deposit take place. If one account is debited and the other is not credited, it does not qualify as a transaction. |
| **Consistency** | TPS systems exist within a set of operating rules (or integrity constraints). If an integrity constraint states that all transactions in a database must have a positive value, any transaction with a negative value would be refused. |
| **Isolation** | Transactions must appear to take place in seclusion. For example, when a fund transfer is made between two accounts the debiting of one and the crediting of another must appear to take place simultaneously. The funds cannot be credited to an account before they are debited from another. |

| | |
|---|---|
| **Durability** | Once transactions are completed they cannot be undone. To ensure that this is the case even if the TPS suffers failure, a log will be created to document all completed transactions. |

These four conditions ensure that TPS systems carry out their transactions in a methodical, standardized and reliable manner. So Transactions must be ongoing. This means that at what time that decisive seat in the movie hall has been booked and we have received proclamation that the chair is ours, it is everlastingly recorded. No matter what problems happen to the system; there are back-ups in place in the transaction processing system to make confident that the witness stays everlasting.

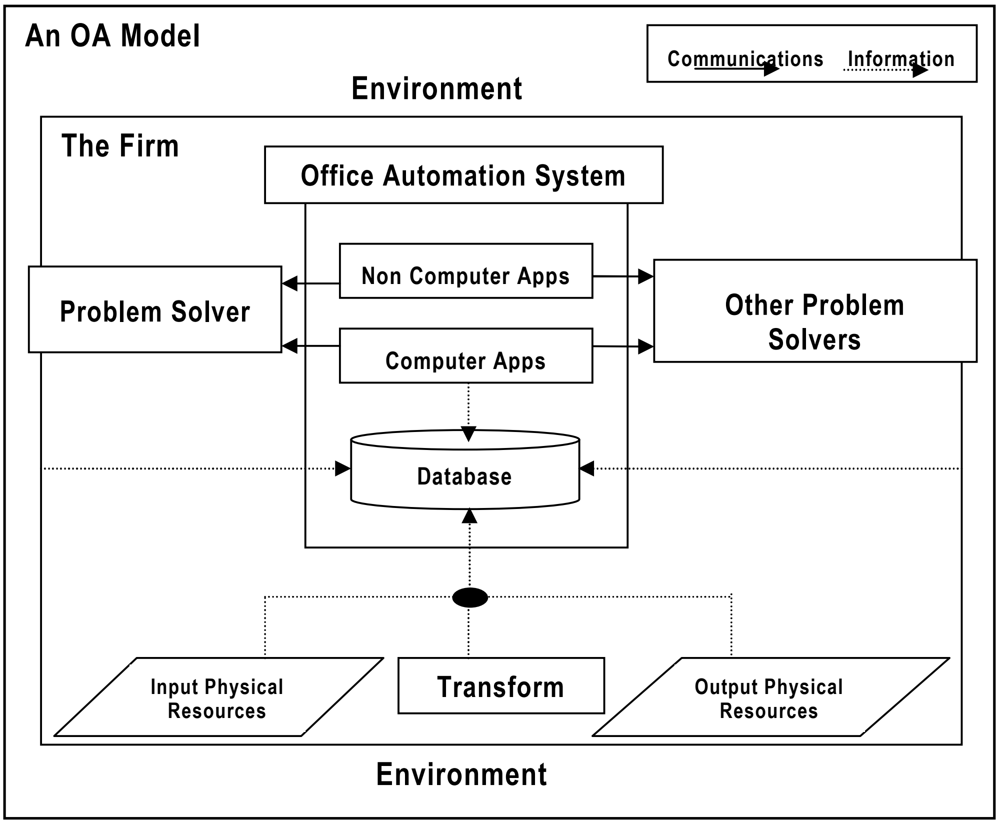
### 4.6.2 Office Automation Systems (OAS)

Office automation almost always implies a network of computers with a variety of available programs. The expression Office Automation refers to the entire tools and methods that are applied to office activities which formulate it achievable to practice written, visual, and sound data in a computer-aided mode. Office automation is anticipated to make available elements which make it achievable to make straightforward, get better, and mechanize the organization of the activities of a company or a group of people (management of administrative data, synchronization of meetings, etc.).

The **Office Automation Systems (OAS)** is an amalgamation of hardware, software, and other resources used to smooth the progress of communications and augment efficiency. Office automation refers to the use of computer and software to digitally generate, collect, store, manipulate, and relay office information needed for accomplishing basic tasks and goals.

If we set out into the diffusion of the expression, office automation refers to all apparatus and methods that are functional to office activities which construct it promising to progression written, visual, and sound data in a computer-aided approach. Office automation is predictable to formulate available elements which create it probable to construct clear-cut, recuperate, and automate the organization of the activities of a company or an assemblage of people (management of administrative data, synchronization of meetings, etc.). Considering that company organizations demand augmented communication, in the present day, office automation is no longer limited to essentially capturing handwritten notes. In meticulous, it in addition comprises the following activities:

- Exchange of information;
- Management of administrative documents;
- Handling of numerical data; and
- Meeting, planning and management of work schedules.




**Diagrammatical view**

An Office Automation Model consists of:

(a) Information and Communication

- No data

(b) Computer and non-computer applications

(c) "Other problem solvers"

- Internal

- Environmental

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∗ "Raymond McLeod, Jr. and George Schell, "The Virtual Office, Chapter 14 Management Information Systems 8/E, Copyright 2001 Prentice-Hall, Inc.

From the Fig. 4.6.3, it is well versed that Office Automation system takes into consideration the Computer applications and other problem solving tool along with a database to transform input into output. Some of the Office automation Applications is as follows in the Table 4.6.3:

**Table 4.6.3: Examples of Office Automation Applications**

| Application | Description |
|---|---|
| **Word Processing** | Use of a computer to perform automatically many of the tasks necessary to prepare typed or printed documents. |
| **Electronic mail** | Use of a computer network that allows users to send, store and retrieve messages using terminals and storage devices. |
| **Voice Mail** | Requires computers with an ability to store audio messages digitally and convert them back upon retrieval. |
| **Electronic Calendaring** | Use of a networked computer to store and retrieve a manager's appointment calendar. Allows other managers' calendars to be accessed and facilitates scheduling. |
| **Video Conferencing** | Use of television equipment to link geographically dispersed conference participants. |
| **Desktop Video Conferencing** | Video and audio equipment are attached to each workstation in the network enabling the two-way communication of picture and way communication of picture and sound. |
| **FAX** | Uses special equipment that can read a document at one end of a communication channel and make a copy at the other end. |
| **Imaging** | Uses Optical Character Recognition (OCR) to convert data on paper to a digital format for storage in a secondary storage device. |
| **Desktop Publishing** | Uses a computer to prepare output that is very close in quality to that produced by a typesetter. |

Thus OAS is to use new technology to get a better working environment. So Office Automation is a widespread appearance that includes an all-embracing variety of applications of computer, communication and information technologies in office surroundings. Despite the actuality that automation is in dull circumstances of flux, the size of the market is enormous, with twelve-monthly investments calculated in billions of dollars. Mechanization has untouched not any more than our work environment, but our very impression of work.

### 4.6.3 Knowledge Management System (KMS)

The world is moving swiftly in the direction of a knowledge-based system as enterprises adapt more and more cost-cutting measure. There is a paradigm shift from an economy principally concerned by the management of tangible resources (equipment, machinery, buildings, ....) to an economy in which renovation and growth are determined by intangible resources and investments (knowledge, technology, competencies, abilities to innovate....). Information and Knowledge are the key elements of this economy. A firm's competitive gain depends on its knowledge processing i.e. what it knows; how it uses & how fast it can know something new.

It's much more influential than the harmony of land, labor & capita (i.e. three most important production factors). Even though there is not a lucid and exclusive definition of the so-called knowledge-based or knowledge-driven economy, it seems to be unstated as the 'upshot of a set of structural changes':

**Knowledge Management Systems (KMS)** refer to any kind of IT system that stores and retrieves knowledge, improves collaboration, locates knowledge sources, mines repositories for hidden knowledge, captures and uses knowledge, or in some other way enhances the KM process. KMS treats the knowledge component of any organization's activities as an explicit concern reflected in strategy, policy, and practice at all levels of the organization.

There are two broad types of knowledge—**Explicit** and **Tacit** as shown in the Fig. 4.6.4. KMS makes a direct connection between an organization's intellectual assets — both explicit [recorded] and tacit [personal know-how] — and positive results.

- **Explicit knowledge:** Explicit knowledge is that which can be formalized easily and as a consequence is easily available across the organization. Explicit knowledge is articulated, and represented as spoken words, written material and compiled data. This type of knowledge is codified, easy to document, transfer and reproduce. For example – Online tutorials, Policy and procedural manuals.
- **Tacit knowledge:** Tacit knowledge, on the other hand, resides in a few often-in just one person and hasn't been captured by the organization or made available to others. Tacit knowledge is unarticulated and represented as intuition, perspective, beliefs, and values that individuals form based on their experiences. It is personal, experimental and context-specific. It is difficult to document and communicate the tacit knowledge. For example – hand-on skills, special know-how, employee experiences.

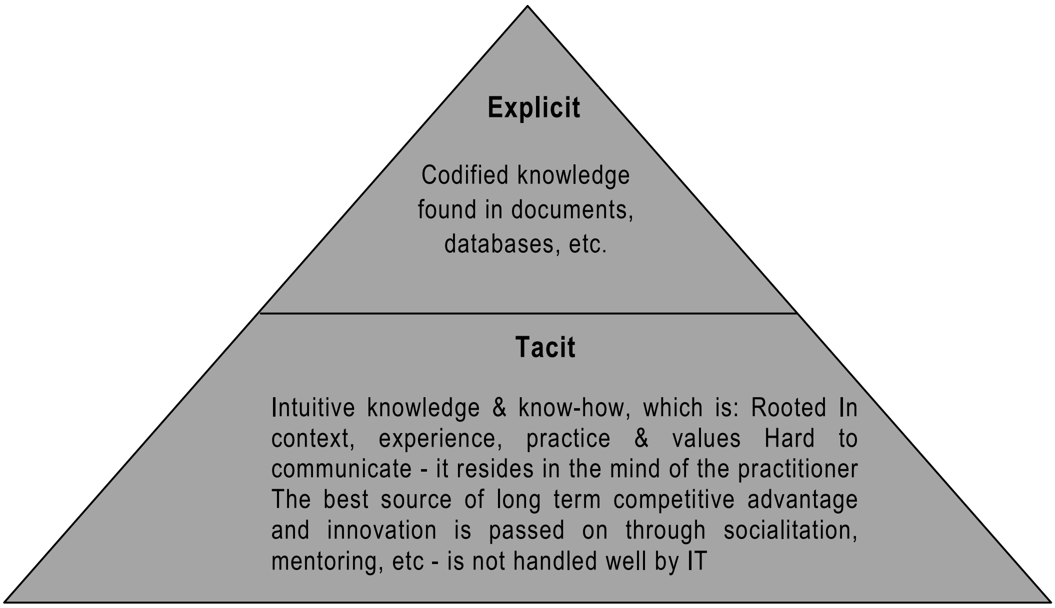


**Fig. 4.6.4: Types of Knowledge**

It is this tacit knowledge that differentiates between organizations when push comes to shove, and hence provides the strategic edge to any organization. A regular example in the software industry is how to write code to get around a particular limitation, or to include a particularly tricky condition.

Referring to the Fig. 4.6.5, a knowledge base is a special kind of database for knowledge management. It is an information repository that provides a means for information to be collected, organized, shared, searched and utilized. It can either be machine-readable or intended for human use.

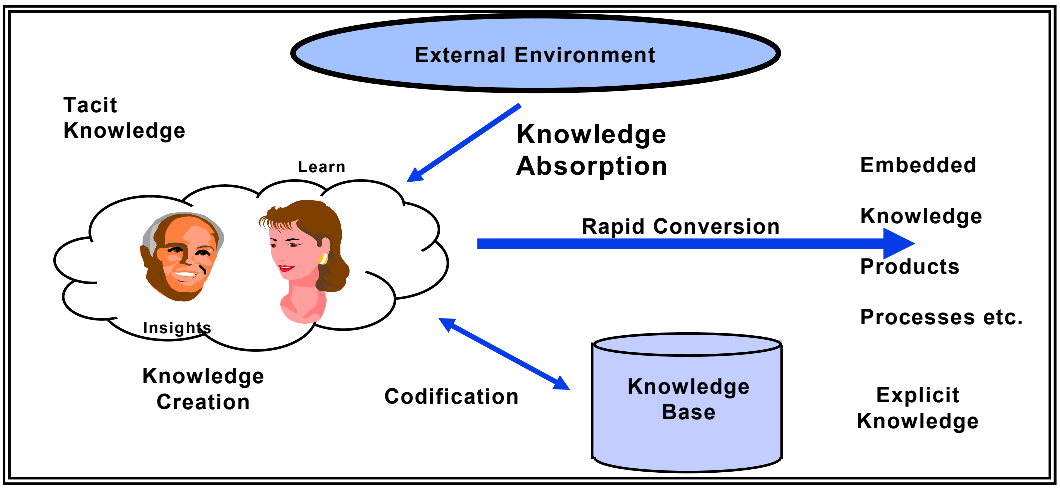


**Fig. 4.6.5: Knowledge Environment**

A Knowledge Discovery in databases system is a value-added intranet, with facilities to search and identify captured knowledge, or identify experts who have the knowledge. The system will also help us establish contact with the expert and have a dialogue with them. It will then capture and make available the transcripts of such discussions, whether they be on chat, e-mail or discussion forums.

### A. Link between Information and Knowledge

Information touches all human action – it is repeatedly said that we survive in the 'Information Age'. Information is an important resource to an organization. It represents an organization's tangible and intangible resources and all transactions relating to those resources. Information influences the way an organization operates. The right information, if it is delivered to the right person, in the right fashion, and at the right time, can improve and ensure organizational effectiveness and efficiency. The information system is the mechanism used to manage and control the information resource.

Knowledge is power. Knowledge is derived from information. Knowledge represents information with a potential use retained for reference in future decision situations. Information is necessarily subjective. Information must always be set in the context of its recipient. The same data may be interpreted differently by different people, depending on their existing knowledge. For example, ₹ 3450/- is data, my bank account has a balance of ₹ 3450/- is information and if my balance falls below ₹ 2500/- I shall have to pay minimum balance charge, is knowledge.

A close and firm link between information and knowledge has always existed.

- Information is piecemeal, fragmented, particular, whereas knowledge is structured, coherent, and often universal.
- Information is timely, transitory, perhaps even short-lived, whereas knowledge is of enduring significance.
- Information is a flow of messages, whereas knowledge is a stock, largely resulting from the flow, in the sense that the "input" of information may affect the stock of knowledge by adding to it, restructuring it, or changing it in any way.
- Information is acquired by being told, whereas knowledge can be acquired by thinking. Thus, new knowledge can be acquired without new information being received.

To sum up, data refers to the raw figures, information is essentially data in a context and knowledge is interpreted data/information which will also be very well presented with the help of following Fig. 4.6.6.

The Figure illustrates the relationships and dependencies between information and knowledge management. Knowledge Management encompasses both the content and the process of creating the content. It refers both to what is known and how it came to be known. In process terms, knowledge represents the human ability to recognize new patterns in content and to relate these to older patterns, in context.

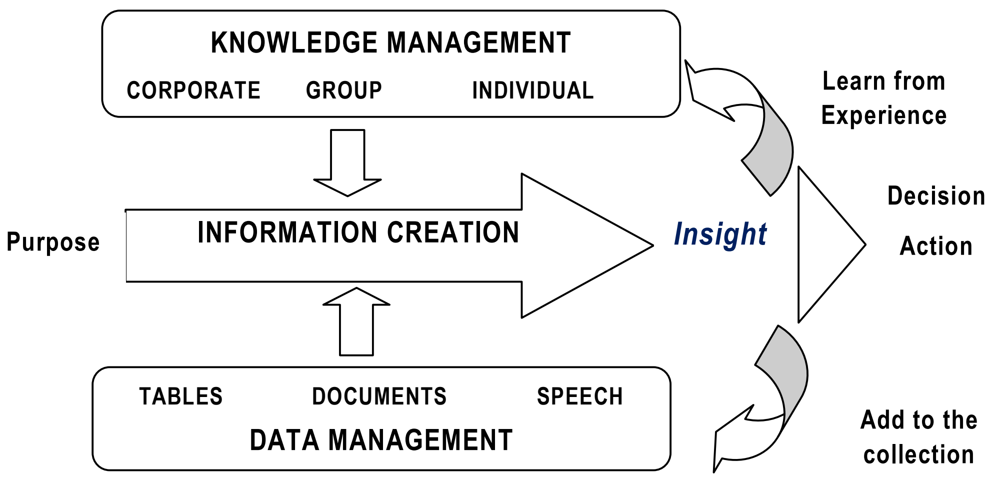


**Fig. 4.6.6: Information Creation through Knowledge Management**

### B. Understanding the Importance of Knowledge Management

The new millennium is seeing the emergence of a knowledge society where the only differentiator between success and failure, for individuals, societies and corporations, is the knowledge they acquire and use. Before probing into the cryptic and still nebulous art and science of knowledge management, let us comprehend the term “knowledge” itself in an organizational context. The difference between the normal and the abnormal handling of any task, process or interaction-between employees, with the customers or with any other stake holder of the firm–has always been the explicit and tacit usage of knowledge by the person guiding the transactions. This knowledge has often been confused with information and sometimes with wisdom because of the somewhat blurred boundaries that exist between the three. It is important to understand that information is nothing but the outcome of the processing of large amounts of data that are created during the regular operations of any organization. This is the form of Management Information Systems to Decision Support Systems to Enterprise Resource Planning.

### C. Why Knowledge?

Knowledge is a sum total of “What everybody knows” about the community world. It is a gathering of values, wisdom, education, experience, morals, and dissemination. Before we gamble into how to deal with knowledge, it’s indispensable to have a comprehensible understanding of what we indicate by knowledge, so that we be on well-known terms with what it is that we’re setting out to administer, and what falls outside the ambit of our Knowledge Discovery in Databases exercise.

**Knowledge Discovery and Data Mining (KDD)** fundamentally deals with ways and means of capturing and making obtainable knowledge of the experts to others, in electronic form. Knowledge Discovery in Databases systems also assist us establish, contact, and communicate with experts (knowledgeable people) on various subjects, surrounded by our organization, or perhaps even outside. Knowledge worker (also referred to as an intellectual worker or brain worker) is a key intellect who is employed owing to his or her acquaintance of a subject matter, rather than their ability to perform manual labor. It includes those in the information technology fields, such as computer programmers, systems analysts, technical writers or the people outside of information technology but who are hired for their knowledge of a few subjects, such as lawyers, teachers, and scientists.”

There are confident factors that show “Why knowledge has gained so much momentum in recent times”? These are discussed as below:

- **Altering Business surroundings:** Previously the business environment used to be stable one, so the people of any organization naturally became knowledgeable over time. They absorbed and hang out knowledge about company’s product & service, its market, customers, competitors and suppliers. But now rapid change means speedy knowledge obsolescence, so need is there to manage it before it disappears without leaving a trace.

- **Burgeon Connections:** Extremely dispersed operations, global expansion, continual change –none of these would have been possible if it was not possible to deploy knowledge officially and deliberately .Cheap computing has made it probable. IT is now translucent to the user and is more accomplished of capturing knowledge. The authentic, interactive networks can put knowledgeable people in stroke through communication & technologies.
- **Globalization:** It's putting heaviness on firms for innovation as markets are at the present release for new-fangled players and competition is stiff. The scenery of goods and services has changed. Now companies have started selling knowledge in addition. For a research lab or software firm, not managing knowledge is similar to Wal-Mart not managing inventory.
- **Modification in Organizational composition:** In today's state of affairs, the organizational structures are changing. The new arrangement is that of "Virtual Organization". This composition is used to integrate far flung operations & Knowledge Discovery in Databases is required.

**D. Difference between Information and Knowledge**

Information is "know what" despite the fact that knowledge is "know-how." Information is "what is" at the same time as knowledge is "what works." Information that helps achieve an action well again is knowledge. To a doctor, most of the contents of a distinctive daily newspaper is basically information – interesting but not helpful for effectual action as a doctor; nevertheless, an piece of writing from a medical periodical in her field of specialty that improves her capability to make a diagnosis or become aware of a recently exposed disease is knowledge. If a knowledge worker answers "yes" to the question, "does this facilitate me do my occupation better?" then it is knowledge.

Thus the knowledge based information technology is that enabler which turns the knowledge into a valuable industrial community. Around these factors the Information age economy is growing, for which the fundamental source of wealth are knowledge and communication rather than natural resources and physical labor.

## 4.6.4 Management Information System (MIS)

**Management Information System** is an old management tool, which has been long used by people for superior management and scientific decision making. Management Information System is primarily dependent upon information, which is a vital ingredient of any Management Information System. Information is the most critical resource of Management Information System. We all know that information is a vital factor for our existence. Just as our body needs air, water and clothes, we are as much dependent upon information.

Before going into the details of what is Management Information System, we all ought to know the meaning of three different terms which form Management Information System as discussed through Fig. 4.6.7.

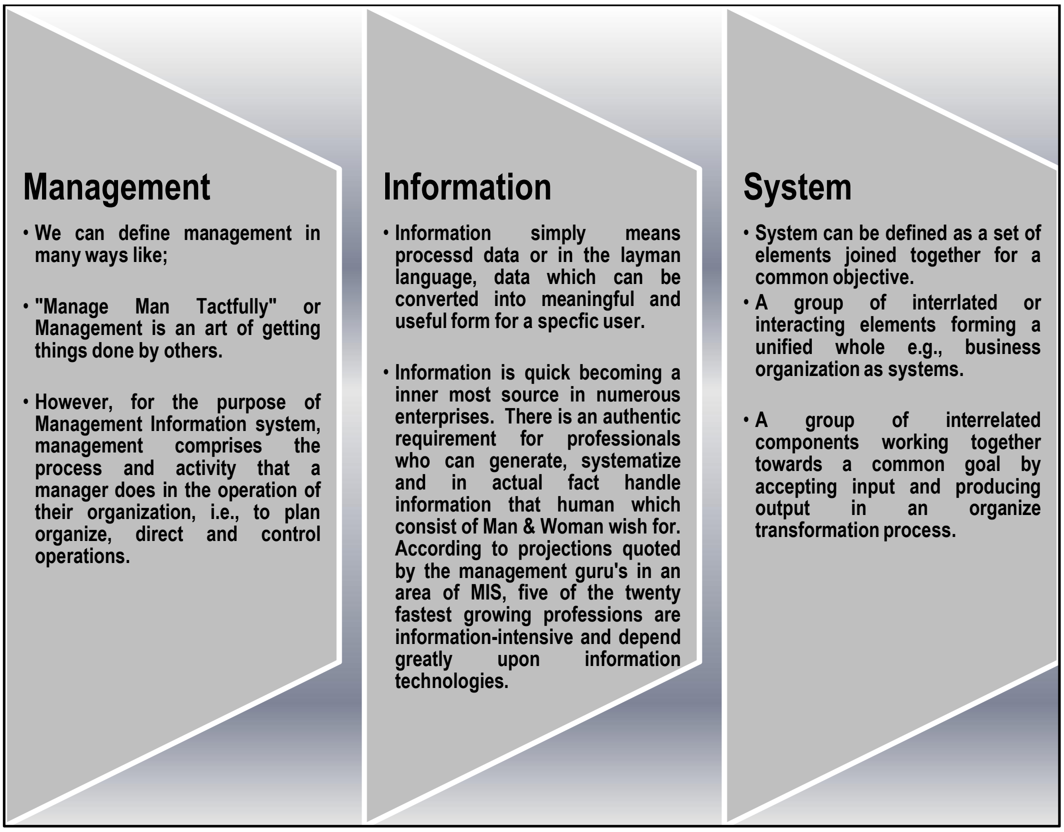


**Fig. 4.6.7: Exploratory Thought on MIS**

**Definitions of MIS**

The term ‘Management Information System’ (MIS) refers to the data, equipment and computer programs that are used to develop information for managerial use.

Like most complex systems, a MIS may be described in a number of different ways:-

- Management Information System is an integrated, user-machine system for providing information to support operation, management and decision-making functions in an organization.
- A Management Information System aims at meeting the information needs of managers, particularly with regard to the current and past operations of the enterprise.
- In the very simple words, MIS is the management of information systems.
- Management Information System is a system which provides accurate, timely and meaningful data for management planning, analysis and control to optimize the growth of the organization.

- Management Information System is also defined as a system that aids management in making, carrying out and controlling decisions" Here management information system is a system that aids management in performing its job.

**A. MIS is an Integrated Application**

MIS is an integrated information system that serves all departments within an enterprise. Evolving out of the manufacturing industry, MIS implies the use of packaged software rather than proprietary software in black and white by or for one customer. As the internet has developed, all of the foremost MIS solutions have now been written to be accessed via web browsers. While developing an integrated MIS system one should follow certain steps as shown in the Fig. 4.6.8.

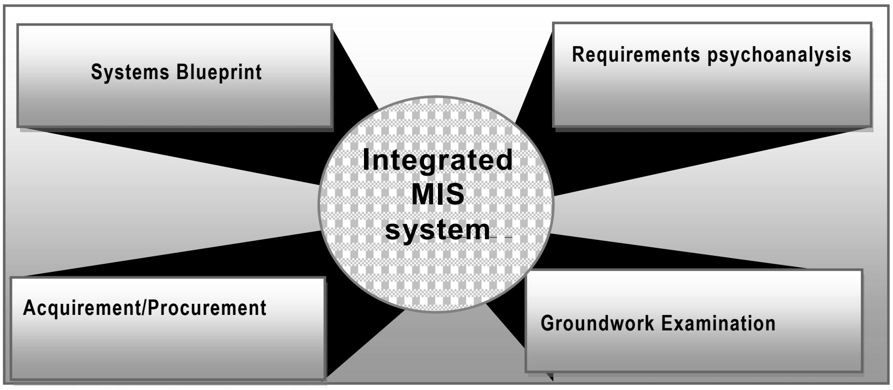


**Fig. 4.6.8: Integrated MIS System**

| | |
|---|---|
| **Groundwork examination**<br>⇒ The problem<br>⇒ Magnitude and scope<br>⇒ Alternatives<br>⇒ Viability and cost effectiveness | **Requirements psychoanalysis**<br>⇒ Knowing the primary and secondary users<br>⇒ Ascertaining user needs<br>⇒ Primary and secondary sources of information<br>⇒ Design, development and implementation needs |
| **Systems blueprint**<br>⇒ Inputs<br>⇒ Processing<br>⇒ Outputs<br>⇒ Storage<br>⇒ Procedures<br>⇒ Human resources | **Acquirement /procurement**<br>⇒ Compatibility<br>⇒ Cost effectiveness<br>⇒ Performance standards<br>⇒ After sales service<br>⇒ Configuration<br>⇒ Portability |

### B. Developing MIS – Dos and Don'ts

Once we are in the process of developing MIS or rather makeup our mind to implement MIS, the best way is to accomplish some homework which can facilitate in finding out what is right and what is wrong. Refer Table 4.6.2.

**Table 4.6.2: Developing MIS – Dos and Don'ts**

| S No. | Particular | Do's | Don't |
|---|---|---|---|
| 1 | **Layman** | Have simpler and manageable system | Be ambitious |
| 2 | **Bridging** | Develop common understanding between consultant and the organization | Be unrealistic in developing action plan |
| 3 | **Contribution in Totality** | Involve programmer in needs assessment | Delay decisions on hiring application developer/s |
| 4 | **Tailor-made** | Customize off-the-shelf software | Depend heavily on the Consultant |
| 5 | **Interpretation** | Have simple software for users to handle | Invest heavily in in-house application development |
| 6 | **Synchronization** | Extensively involve users in MIS development | Let vendors determine hardware needs for LAN |
| 7 | **Application** | Adopt modular approach for s/w development | Go for large applications |

### C. Some Examples of MIS

- Airline reservations (seat, booking, payment, schedules, boarding list, special needs, etc.)
- Bank operations (deposit, transfer, withdrawal) electronically with a distinguish payment gateways
- Integration of department with the help of contemporary software's like ERP
- Logistics management application to streamline the transportation system
- Train reservation

So Management Information Systems provide decision-makers with preselected types of information. MIS is generally in the form of computer-generated reports and usually generated from data obtained from transaction processing systems.

### 4.6.5 Decision Support Systems (DSS)

DSS were introduced in the 1970s and expanded mainstream attention in the 1980s. In the beginning run principally on mainframes, they were witness as an evolutionary step from management information systems, which at the time were reasonably rigid storehouses of corporate data. In that environment, DSS were high-end applications reserved for occasional, non-recurring strategic decisions by senior management. The speedy advances in personal computers ushered in a new variety of straightforward and comprehensively used DSS. Positively, some experts think about the built-in.

#### A. Meaning and Definition

Decision Support Systems (DSS) are a contradictory compilation of interactive computer tools—first and foremost customizable software—designed to lend a hand in decision-making. They thrust into a broader class acknowledged as Management Support Systems (MSSs). The concept of a Decision Support System (DSS) is extremely broad and its definition varies depending on the author's point of view. Some of the definitions of DSS from various sources that provide a much elaborative view of it are as follows:

- A **Decision Support System (DSS)** is a computer-based information system that supports business or organizational decision-making activities. DSSs serve the management, operations, and planning levels of an organization (usually mid and higher management) and help to make decisions, which may be rapidly changing and not easily specified in advance. DSS can be either fully computerized, human or a combination of both.
- A properly designed DSS may be defined as an interactive software-based system intended to help decision makers compile useful information from raw data, documents, personal knowledge, and/or business models to identify and solve problems and make decisions.
- DSS can be extremely beneficial to any organization's overall performance. However, DSS can also be the cause of great confusion, misperception and even inaccurate analysis – these systems are not designed to eliminate "bad" decisions. DSS are there to facilitate a manager in making operational decisions, but the ultimate burden of responsibility lies with the manger. Managers can sometimes be over-optimistic in their expectations of a DSS and develop a unrealistic reliance on the system.
- Decision support system (DSS) covers a wide variety of systems, tools and technologies. Some people think the term DSS is dated and that it has been replaced by a "new type" of system called on-line analytical processing or OLAP. Others seem to emphasize creating knowledge-based DSS as the "state-of-the-art" in decision support systems. Operations researchers primarily focus on optimization and simulation models as the "real" DSS.

Two types of planning languages that are commonly used in DSS are: **General-purpose planning languages** and **Special-purpose planning languages**. These are discussed below:

- **General-purpose planning languages** allow users to perform many routine tasks, for example; retrieving various data from a database or performing statistical analyses. The languages in most electronic spreadsheets are good examples of general-purpose planning languages. These languages enable user to tackle abroad range of budgeting, forecasting, and other worksheet-oriented problems.
- **Special-purpose planning languages** are more limited in what they can do, but they usually do certain jobs better than the general-purpose planning languages. Some statistical languages, such as SAS and SPSS, are examples of special purpose planning languages.

DSS has following basic components:

**(a)** **The user: The user** is usually a manager with an unstructured or semi-structured problem to solve and may be at management - level of an organization.

**(b)** **One or more databases: Databases** contain both routine and non-routine data from both internal and external sources.

**(c)** **Model Base: Model base** is the brain of the DSS as it performs data manipulations and computations with the data provided to it by the user and the database. The planning language in DSS allows the user to maintain a dialogue with the model base.

The ambition of a DSS is to construct management more resourceful and victorious, mainly with extemporized and flexible decisions (versus regular or programmatic ones that entail little judgment). Interactivity is key; unlike related expert systems and numerous artificial intelligence tools, DSS usually do not endeavor to make the decision themselves, but to a certain extent present information in a mode that is favorable to making an informed and well-organized decision.

From the Fig. 4.6.9, Decision Support Systems are not entirely different from other systems and require a structured approach. Such a framework includes people, technology, and the development approach. The early Framework of Decision Support System consists of four phases:

| |
|---|
| ♦ **Intelligence -** Searching for conditions that call for decision. |
| ♦ **Design -** Inventing, developing and analyzing possible alternative actions of the solution. |
| ♦ **Choice -** Selecting a course of action among those. |
| ♦ **Implementation -** Adopting the selected course of action in decision situations. |

In the real world, the stages of decision making described here do not necessarily follow a linear path. One can be in the process of implementing a decision, only to discover that his/her solution is not working. In such cases, one will be forced to repeat the design, choice, or perhaps even the intelligence stage. For instance, in the face of declining sales, a sales management team may strongly support a new sales incentive system to spur the sales force on to greater effort. If paying the sales force a higher commission for making more sales does not produce sales increases, managers would need to investigate whether the problem stems from poor product design, inadequate customer support, or a host of other causes, none of which would be "solved" by a new incentive system.

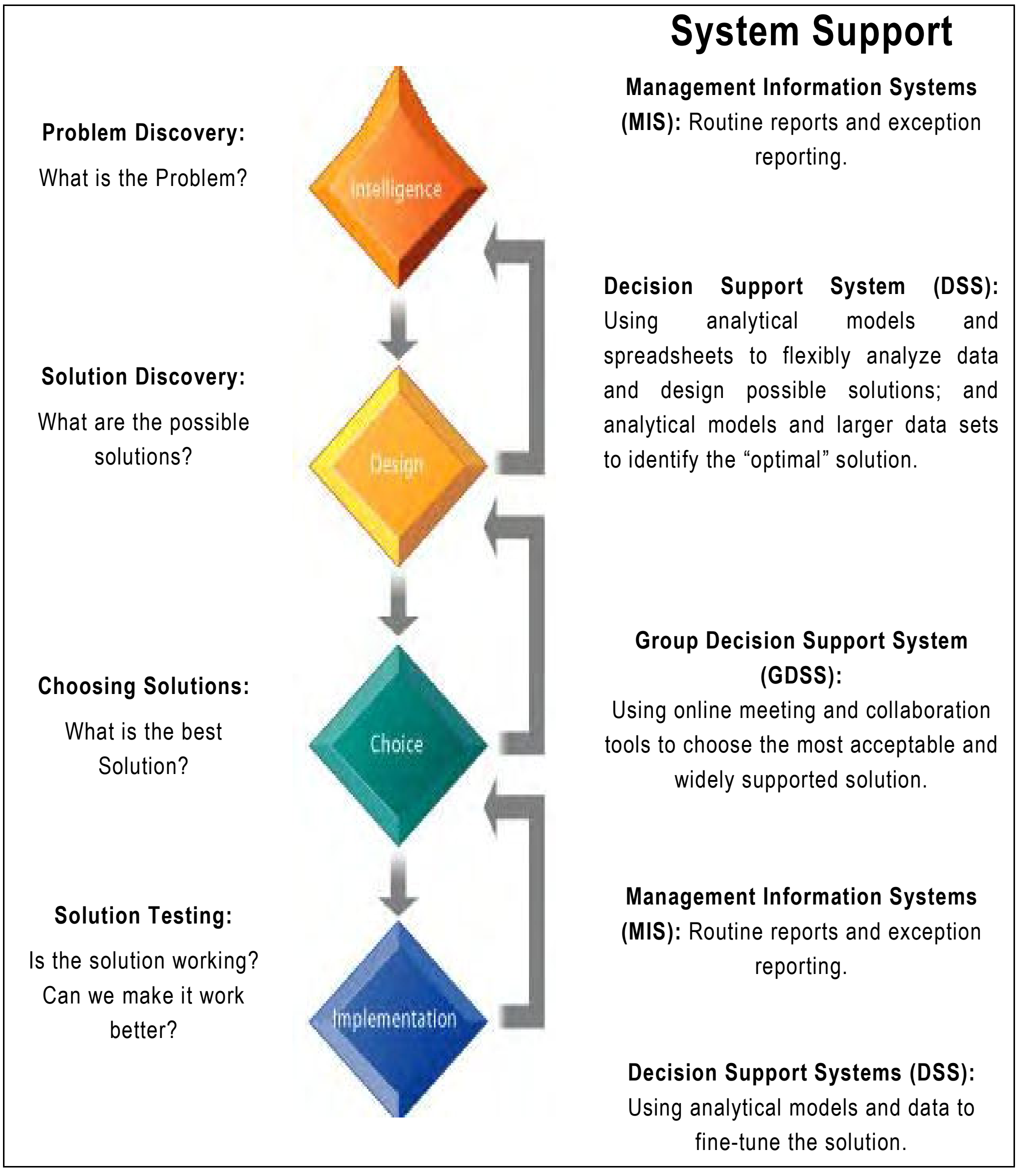


**Fig. 4.6.9: DSS structured approach**

Thus a DSS helps users to:

- engender data models and "what if" scenarios
- manipulate data directly
- premeditated to make non-routine decisions
- slot in data from external sources

### 4.6.6 Executive Information Systems (EIS)

An **Executive Information System (EIS)** is the nature of IS used by executives to access and administer the data they entail to make informed business decisions. Even though there are tools for managing an executive information system, the EIS in itself is not an instrument, but rather, an infrastructure within a company. In the hierarchical structure of information systems, the EIS is at the pinnacle and is designed to renovate all significant data (from project to process to budget) into aggregated information that makes sense and brings value to the by and large business strategy.

As per the Business Dictionary "EIS is not a piece of hardware or software, but an infrastructure that supplies to a firm's executives the up-to-the-minute operational data, gathered and sifted from various databases. The typical information mix presented to the executive may include financial information, work in process, inventory figures, sales figures, market trends, industry statistics, and market price of the firm's shares. It may even suggest what needs to be done, but differs from a Decision Support System (DSS) in that it is targeted at executives and not managers."

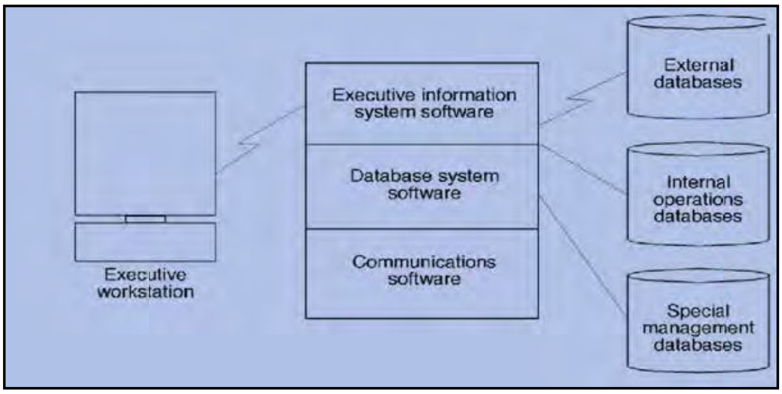


**Fig. 4.6.10: Components of Executive Information System***

It is clear from the Fig. 4.6.10 that EIS and special software is one of the important components of Executive workstation and facilitates external databases, internal operations databases management database.

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* "Introduction to Information Systems" by James O'Brien, George M. Marakas, 11th edition, McGraw Hill

Alternative names of EIS are Enterprise Information Systems or Executive Support Systems (ESS). EIS is able to link data from various sources both internal and external to provide the amount and kind of information executives find useful. These systems are designed for top management; easy to use; present Information in condensed view; access organization's databases and data external to the organization.

The components of an EIS can typically be classified as shown in the Table 4.6.4.

**Table 4.6.4: Components of an EIS**

| Component | Description |
| --- | --- |
| Hardware | Includes Input data-entry devices, CPU, Data Storage files and Output Devices. |
| Software | Includes Text base software, Database, and Graphic types such as time series charts, scatter diagrams, maps, motion graphics, sequence charts, and comparison-oriented graphs (i.e., bar charts) Model base. |
| User Interface | Includes hardware (physical) and software (logical) components by which people (users) interact with a machine. Several types of interfaces can be available to the EIS structure, such as scheduled reports, questions/answers, menu driven, command language, natural language, and input/output. |
| Telecommunication | Involves transmitting data from one place to another in a reliable networked system. |

Thus Executive Information Systems (EIS) are high-risk/high-return systems; principally because the clientele these systems serve are not merely important in the unyielding, but encompass information needs that are extremely easier said than done to provide through computer-based information systems. As a consequence, it is significant to appreciate the explanation to victorious EIS development and constant operation.

## 4.7 Specialized Systems

Specialized Systems provide comprehensive end to end IT solutions and services (including systems integration, implementation, engineering services, software application customization and maintenance) to various corporations in India and other part of a world. Specialized Systems also offer comprehensive solutions to various sectors to confront challenges, and convert every challenge into an opportunity. There are various specialized systems which can be used in a following way:

### 4.7.1 Enterprise Resource Planning (ERP)

The perception of an integrated information system starts on the factory floor. Manufacturing software developed during the 1960s and 1970s, evolved from trouble-free inventory tracking systems to materials' requirements planning software. Companies realized that the management and flow of information were just as important as materials and inventory management. It is defined by some renowned researchers that ERP system is rooted in Materials Requirement Planning (MRP-I) and Manufacturing Resource Planning (MRP-II) System.

**Enterprise Resource Planning (ERP)** systems integrate internal and external management information across an entire organization—taking on finance/accounting, manufacturing, sales and service, customer relationship management, etc. ERP systems automate this activity with an integrated software application. The rationale of ERP is to make easy the flow of information between all business functions in the interior boundaries of the organization and control the connections to exterior stakeholders.

ERP has also evolved considerably with computer and technological advances. Enterprise Resource Planning popularly known as 'ERP' is a description of systems that employ innovative information technology to manage all sorts of areas in companies. Major corporations, in particular, could hardly function without tailor-made ERP software.

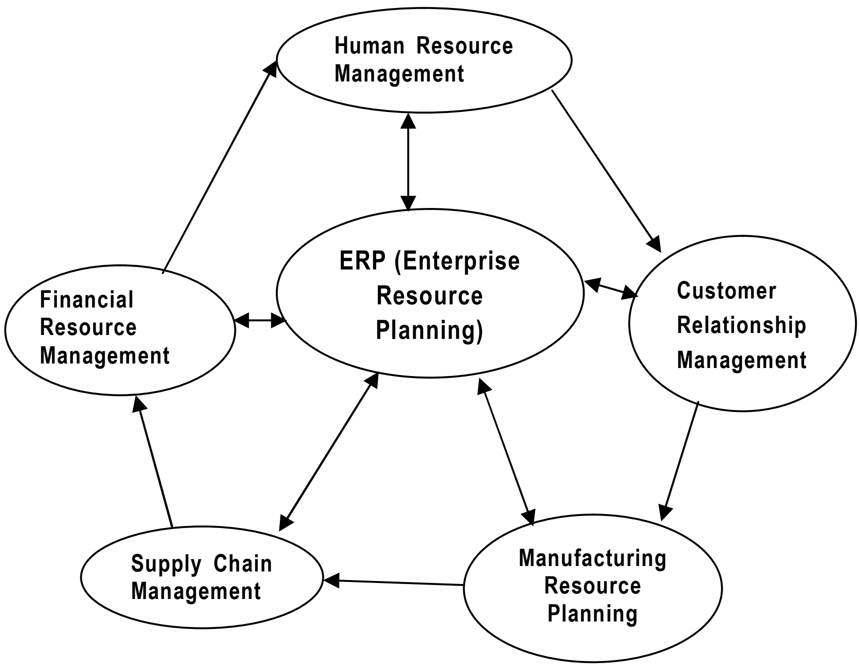


**Fig. 4.7.1: ERP linkages with various Modules**

Thus the above Fig. 4.7.1 shows how the various systems which we would explain in a forthcoming heads are linked with one another and facilitate each other as and when required.

Thus successful management of emerging technologies has been most noteworthy in supporting the new and emerging management philosophies, where the emphasis is on allocation of information, facilitated by simpler and easier data access. ERP software facilitates competent and efficient administration, and mechanized business activities. It is a complete software solution package for enhancing the performance in large organizations and meeting their requirements with ease and efficacy.

Brief overview of the each of the above stages is provided here in the Table 4.7.1 for understanding the diverse stages of implementing an ERP solution in an enterprise.

**Table 4.7.1: ERP Stages of Implementation**

| | |
|---|---|
| **Stage -1**<br>**Inventory Control** | It is the supervision of supply, storage and accessibility of items in order to make certain a sufficient supply without excessive oversupply. It can also be referred as internal control - an accounting procedure or system designed to encourage competence or give surety the implementation of a strategy or maintain assets or avoids fraud and error etc. |
| **Stage – 2**<br>**ABC Analysis** | ABC analysis is that technique of material control in which we divide our material into three categories and investment is done according to the value and nature of that category's materials. After this, we control of material according to their level of investment. We need not to control all the categories but we have to control those materials which are in a category. The ABC approach states that, when reviewing inventory, a company should rate items from A to C, basing its ratings on the following rules:<br>• A-items are goods which annual consumption value is the highest. The top 70-80% of the annual consumption value of the company typically accounts for only 10-20% of total inventory items.<br>• C-items are, on the contrary, items with the lowest consumption value. The lower 5% of the annual consumption value typically accounts for 50% of total inventory items.<br>• B-items are the interclass items, with a medium consumption value. That 15-25% of annual consumption value typically accounts for 30% of total inventory items.<br>Thus it is very well said "The Pareto principle states that 80% of the overall consumption value is based on only 20% of total items." In other words, demand is not evenly distributed between items: top sellers vastly outperform the rest. |
| **Stage – 3**<br>**Economic Order Quantity (EOQ)** | EOQ is used as part of a uninterrupted review inventory system in which the level of inventory is scrutinize at all times and a fixed magnitude is ordered each time the inventory level reaches a particular reorder point. The EOQ provides a model for calculating the suitable reorder point and the optimal reorder quantity to make sure the immediate replenishment of inventory with no shortages. It can be an important tool for small business owners who need to make |

<table>
<tr><td></td><td>decisions about how much inventory to keep on hand, how many items to order each time, and how often to reorder to incur the lowest possible costs.</td></tr>
<tr><td>Stage – 4<br>Just-In-Time (JIT)</td><td>JIT is a philosophy of continuous improvement in which non-value-adding activities (or wastes) are identified and removed for the purposes of:
<table>
<tr><td>• Reducing Cost</td><td>• Improving Quality</td><td>• Improving Performance</td></tr>
<tr><td>• Improving Delivery</td><td>• Adding Flexibility</td><td>• Increase innovativeness</td></tr>
</table>
When the JIT principles are implemented successfully, significant competitive advantages are realized. JIT principles can be applied to all parts of an organization: order taking, purchasing, operations, distribution, sales, accounting, design, etc.</td></tr>
<tr><td>Stage – 5<br>Material Requirement Planning (MRP – I)</td><td>MRP which was nothing but a historical background of ERP, the motive was only to tap inventory i.e. raw materials planning etc. Material requirements planning (MRP) is a production planning and inventory control system used to manage manufacturing processes. Most MRP systems are software-based, while it is possible to conduct MRP by hand as well. An MRP system is intended to simultaneously meet three objectives:<br>• Ensure materials are available for production and products are available for delivery to customers.<br>• Maintain the lowest possible material and product levels in store<br>Plan manufacturing activities, delivery schedules and purchasing activities.</td></tr>
<tr><td>Stage-6<br>Manufacturing Resource Planning - II (MRP – II)</td><td>It is defined as a method for the valuable planning of all resources of a manufacturing company, preferably, it addresses operational planning in units, financial planning, and has a simulation ability to respond "what-if" questions and extension of closed-loop MRP which looks after production related activities. The concept of MRP II evolved was to look after shop floor and distribution management activities.</td></tr>
<tr><td>Stage – 7<br>Distribution Resource Planning (DRP)</td><td>DRP is a method used in business administration for planning orders within a supply chain. DRP enables the user to set certain inventory control parameters (like a safety stock) and calculate the time-phased inventory requirements. This process is also commonly referred to as distribution requirements planning. The objectives of Distribution Resource Planning (DRP) in the SAP R/3 System are:<br>• To improve customer service levels by anticipating customer demand at distribution centers and providing finished products at the correct location when customer needs arise.</td></tr>
</table>

| | |
|---|---|
| | • To provide an accurate requirements plan for manufacturing.<br>To optimize the distribution of available stock in the distribution network using the deployment function. |
| **Stage – 8**<br>**Enterprise Resource Planning** | This has a broader role and is not confined to one department but has an elaborate purview. ERP takes a customer order and provides a software road map for automating the dissimilar stages along the path to fulfilling it. |
| **Stage – 9**<br>**Money Resource Planning (MRP-III) or ERP-II** | This has more emphasis on planning of capital or managing the situation when surplus money arises. MRP-III is said to have been stretch, including the management of the enterprise administrator the Sales and Marketing (Sales & Marketing), Logistics (Logistics), that have the aptitude to look with Financial Accounting (Financial Accounting). |
| **Stage - 10**<br>**EIS-Web Enabled** | Web-based technologies are causing a revisit to existing IT implementation models, including EIS. Web browser software is the cheapest and simplest client software for an EIS. Web enabled EIS is a final step in this direction. |

For example, an ERP allows a company to track sales orders from the order desk, to production planning, purchasing, production, warehousing, shipping and accounts receivable (referred to as "Order to Payment" process). An ERP will also prevent duplication of an order between departments, for example, purchasing and production.

Many manufacturing organizations, mainly those in the private sector, have messaging and groupware in place for intra-organizational communication. Network-centric applications continue to be developed. Some examples are given below.

One elementary factor in optimizing a company's important core business processes is the fast and precise retrieval, integration and collection of information. ERP is a system that uses modern information technology to manage the functions of various company divisions and to create transparency in the process. Through the use of ERP - and, as a result, a single data model for all company-relevant information - significant amounts of internal integration can be achieved. There are various vendors who had given a new shape to ERP business and provide it a great height. SAP, Oracle and Microsoft are few of them. Some of the "popular" ERP packages are SAP, JD Edwards, Baan, Oracle 9 i.

### 4.7.2 Customer Relationship Management (CRM)

**Customer Relationship Management (CRM)** emerged in the information technology community in mid-1990s. The Management Guru's had quoted in their thought provoking statements that "Customer is the sovereign and decisive in a modern day businesses". Acquiring new clients is far more costly than retaining the old profitable customers. This is the common believe with which firms operate in today's global and competitive fierce battlefield of so called marketing. The main objective is to retain as much loyal customers as one can and this has led to the emergence of Customer Relationship Management.

Organizations now have to comprehend the value of CRM i.e., the parameter of identifying, magnetizing and preserving the most valuable customers to prolong profitable growth in a regulated environment, where the endeavors were universal access and the propensity to dish up all customers equally well. **"The Customer Is Always Right -So Always Be Right about Your Customers".** Creating cost-effective approach is an ultimate goal of CRM customers who will prolong to pay money even then when there is a competitive alternative exists. To get that faithfulness and trustworthiness, there is a tremendous need of CRM at every juncture of the organization or rather at every customer touch point.

A. CRM may be defined as a business process in which client relationships; customer loyalty and brand value are built through marketing strategies and activities. CRM allows businesses to develop long-term relationships with established and new customers while helping modernize corporate performance. CRM incorporates commercial and client-specific strategies via employee training, marketing planning, relationship building and advertising.

As we know that competition for market share is fierce due to globalization, accessibility of products through the internet and electronic selling too add to the increasing demands of customers. This increased competition is driving organizations to implement CRM as a business strategy to lend a hand to the business challenges like, declining revenue, cut-off in the profit margin, costs occurred due to lost customers etc. If we go into a depth of using CRM there is a bifurcation of using CRM application.

To accomplish with CRM, companies need to match products and campaigns to prospects elegantly the customer life cycle. CRM encompasses the function and responsibilities of those employees who directly work with customers.

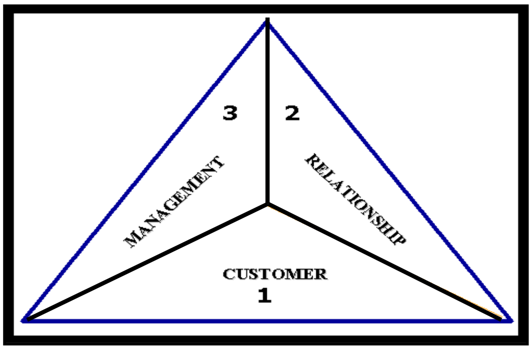


**Fig. 4.7.2: CRM Interpretation**

By seeing the Fig. 4.7.2, these three words have been interpreted as:

⇒ Customer is a '**Human Being'**,

⇒ Relationship is the **'Feeling'** and

⇒ Management is' **Management Tact'** respectively.

So CRM is a combined activity of these three aspects, which perform well only when it will be used in totality.

**Table 4.7.2: CRM Mechanisms**

**Customer:** The customer is the source of the company's profit and future growth. Sometimes it is intricate to find out who is the real customer because the buying decision is a collaborative activity among participants of the decision-making process. CRM provides the abilities to distinguish and manage the customers.

**Relationship:** The relationship between a company and its customers involves continuous bi-directional communication and interaction. CRM involves managing this relationship so it is mutually beneficial. Managing the key customers' relationships competently is a critical factor to the success of the company. The relationship can be short-term/long-term, continuous/discrete, attitudinal/behavioral etc.

**Management:** CRM is not only an activity of marketing department; rather it involves continuous corporate change in the culture and process. The customer information collected and analyzed continuously is transformed into corporate knowledge that leads to activities that take advantage of the information and of market opportunities. CRM software enables us to make a required comprehensive change in the organization and its people.

### A. Some Common Definitions of CRM

#### I. Analytical CRM Definition

**Table 4.7.3: Analytical CRM Definition**

| | |
|---|---|
| **CRM Equation** | Customer Relationship Management **=** Customer Understanding + Relationship Management |
| **Customer Understanding** | Analysis of customer data to gain deep understanding down to the level of individual customer |
| **Relationship Management** | Interaction with the customer through various channels for various purposes |
| **Analytical CRM** | Use customer understanding to perform effective relationship management |

#### II. Greenberg's definition of CRM

This states that CRM must establish with a business strategy, which drives transformation in the business, and influences work processes. These processes are enabled by information technology (IT) and are illustrated with the help of CRM Pyramid. Refer Fig. 4.7.3.

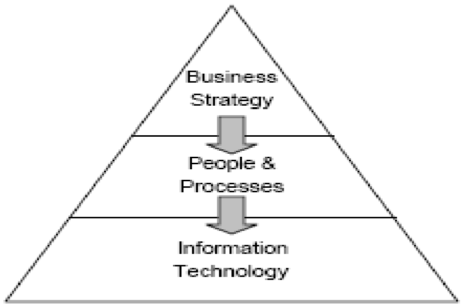


**Fig. 4.7.3: Process of CRM**

**B. Benefits of CRM**

CRM establishes the benefits of generating customer loyalty, raising a market intelligence enterprise, and an integrated relationship. Preserving existing customers and providing enhanced services to accomplish the loyalty is expressed as CRM. The underlying standard that business exists is their customers. Developing connection and affiliation with customer and supervising it professionally and effectively so that it is advantageous to both the customer and the business is a noteworthy objective. This unit will talk about how the effectual deployment of CRM as a software and how it will facilitate an organization in a big way.

CRM applications smoothen the progress to capture, consolidate, analysis, and enterprise-wide dissemination of data from existing and potential customers. CRM can be considered as an amalgamation of people, process and systems rather than just IT application.

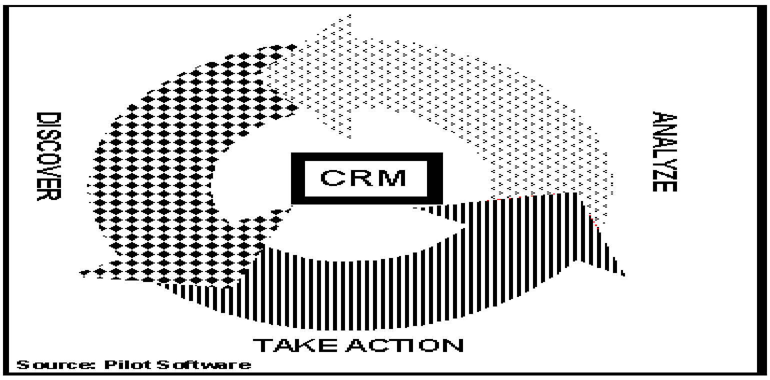


**Fig. 4.7.4: Three ways to CRM**

**Where (Refer Fig. 4.7.4)**

⇒ **Take Action:** Talks about Policies & Procedures, Marketing policies, Support procedures

⇒ **Analyze:** Talks about Customer base Profitability Buying pattern Support pattern Productivity

⇒ **Discover:** Talks about the trends in market selling opportunities for expansion

### C. Why CRM?

The business now-a-days suffer with a dilemma of customer's disconcert, and contemporary marketing efforts from the closing business rivals, which accomplish in attracting new customers. The up-to-date businesses have learned the inflexible mode that it is well-organized to maintain hold of customers than to merely attract new customers. Additionally, loyalty is desired first and foremost in a precise category of the client base. If we go into the depth of the research and studies that shows another expression of the old Pareto Rule **"80/20 rule"** which emphasize that most organizations find that approximately **20%** of their customer base generates **80%** of the profits. It is merely based on the philosophy that indicates that old trustworthy customers are most lucrative and helps in generating profits. It is at the present imperative that businesses make out the noteworthy characteristics of this assemblage, keep hold of these exceedingly desirable customers, and discover ways to augment the size.

The thought behind CRM is to have a single integrated enterprise view of the customer for the rationale of cultivating these high-quality relationships that lead to enhanced loyalty and profits. This means being proficient to recognize all the services/products the customer had fetched from the organization and thus being able to recognize the buying behaviour/pattern of the customer. This would result in the company being able to give to the customer the identical kind of approved experience where customer had been delighted with the service/product. The distinguishing feature of contemporary CRM is the prominence on an enterprise view of the customer, not simply a departmental sight.

## 4.7.3 Supply Chain Management (SCM)

If we go to a BIGBAZAAR or visit a nearby retail store which is in our vicinity and pick up a few items of the shelf from electronics and white goods or even clothes or gadgets and look at the labels, chances are that we will come across them having been manufactured in China or Mexico. The coffee pods we buy to use for our day-to-day use comes from Africa. Computers have been shipped out of South American Factories and Soft furnishings on the shelves are from India and Hong Kong.

Supply Chain Management (SCM) is based on two central ideas. The first is that practically every product that reaches an end user represents the cumulative effort of multiple organizations. These organizations are referred to collectively as the **Supply Chain**. The second thought is that while supply chains have existed for a long time, most organizations have only paid attention to what was happening within their "four walls." Few businesses understood, much less managed, the entire chain of activities that ultimately delivered products to the final customer.

In simple terms, **Supply Chain Management** is a chain that starts with customers and ends with customers. Supply Chain Management may be defined as the process of planning, implementing and controlling the operations of the supply chain with the purpose of satisfying the customer's requirement as efficiently as possible. Supply Chain spans all movement and storage of raw materials, Work-in-process, inventory and finished goods from the point of origin to the point of consumption. Refer to Fig. 4.7.5.


**Fig. 4.7.5: Supply Chain Linkages**

## A. Components of SCM

Referring to the Fig. 4.7.6, the main elements of a supply chain include.

**(a) Procurement/Purchasing**—begins with the purchasing of parts, components, or services. Procurement must ensure that the right items are delivered in the exact quantities at the correct location on the specified time schedule at minimal cost. This means that procurement must concern itself with the determination of who should supply the parts, the components, or the services. It must address the question of assurance that these suppliers will deliver as promised. The key issue in procurement is how one goes about selecting and maintaining a supplier, which can be approached from two directions. The first concentrates on how a firm might evaluate a potential supplier whereas the second is how a firm evaluates those businesses that are already suppliers to an operation.

**(b) Operations** - The second major element of supply chain management system is operations. Having received raw materials, parts, components, assemblies, or services from suppliers, the firm must transform them and produce the products or the services that meet the needs of its consumers. It must conduct this transformation in an efficient and effective manner for the benefit of the supply chain management system.

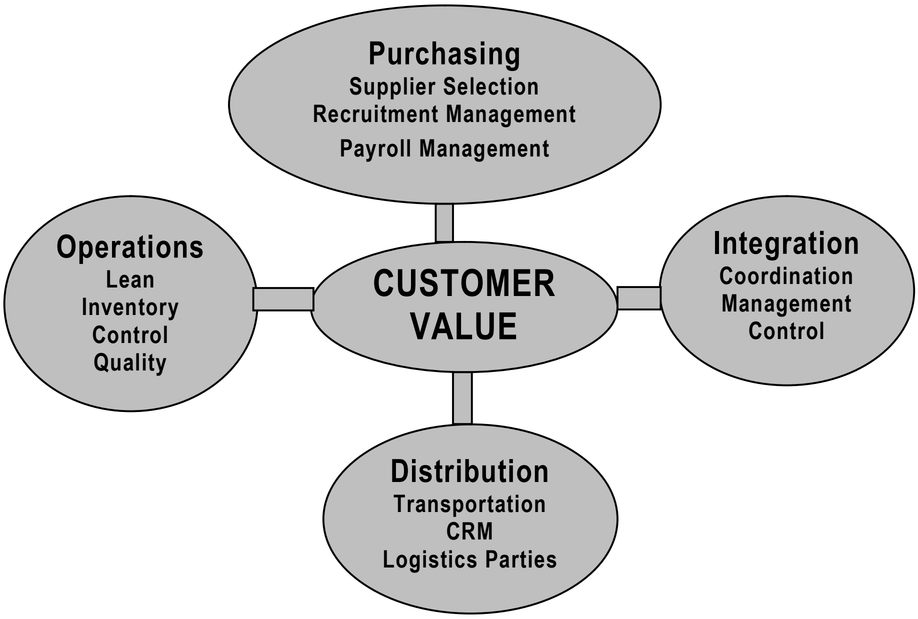


**Fig. 4.7.6: Core Elements of a Supply Chain Management**

**(c) Distribution** - The third element of the supply chain management system is distribution. Distribution involves several activities—transportation (logistics), warehousing, and customer relationship management (CRM). The first and most obvious is logistics—the transportation of goods across the entire supply chain.

**(d) Integration** - The last element of supply chain management is the need for integration. It is critical that all participants in the service chain recognize the entirety of the service chain. The impact of the failure to adopt a system-wide perspective—that is, examining the totality of the chain can significantly increase costs and destroy value.

**Relationship between ERP, CRM and SCM**

CRM and SCM are two categories of enterprise software that are widely implemented in corporations and non-profit organizations. While the primary goal of ERP is to improve and streamline internal business processes, CRM attempts to enhance the relationship with customers and SCM aims to facilitate the collaboration between the organization, its suppliers, the manufacturers, the distributors and the partners.

SCM software chugs along, ensuring that materials and information flow through the supply chain with the highest possible efficiency and the lowest possible cost. Meanwhile, CRM software focuses on the identification, targeting, acquisition and retention of customers, and on the building of strong relationships between the business and its customers as shown in the Fig. 4.7.7.

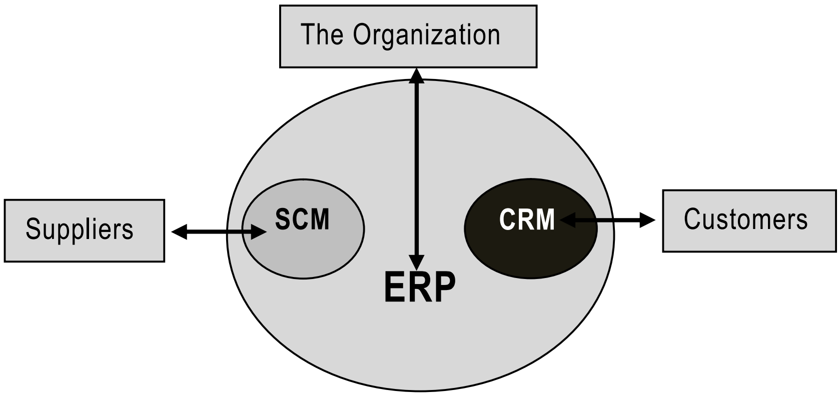


**Fig. 4.7.7: Relationship between ERP, CRM and SCM**

Thus, the two tools tend to sit at opposite ends of the enterprise and deal with different sets of data albeit with the same end goal.

### 4.7.4 Human Resource Management Systems (HRMS)

People are the most valuable asset of an enterprise and substantial time and endeavor has to be spent in managing the human resources. From recruitment and talent acquisition to talent retention and expansion, one invests energies in carefully planning and executing a variety of functions to generate well-organized personnel.

A **Human Resources Management System (HRMS)** is a software application that coalesce many human resources functions, together with benefits administration, payroll, recruiting and training, and performance analysis and assessment into one parcel. In other words, HRMS or Human Resources Information System (HRIS), refers to the systems and processes at the intersection between human resource management (HRM) and information technology.

**Key Integration Points:**

HRMS uniquely provides indigenous integrations from HR Management to other core talent management processes in order to support a holistic, end-to-end cloud talent management strategy. Some of the key modules of HRMS are shown in the Fig. 4.7.8.

- **Workforce Management:** Integrated across the strategic Human Capital Management (HCM) solution, Workforce Management provides powerful tools to effectively manage labor rules, ensure compliance, and control labor costs and expenses.

- **Time and Attendance Management:** The time and attendance module gathers standardized time and work related efforts. The most advanced modules provide broad flexibility in data collection methods, labor distribution capabilities and data analysis features. Cost analysis and efficiency metrics are the primary functions.


**Fig. 4.7.8: Human Resource Management System Modules**

- **Payroll Management:** This module of the system is designed to automate manual Payroll functions and facilitate salary, deductions etc calculations, eliminates errors and free up HR staff for more productive tasks. Data is generally fed from the human resources and time keeping modules to calculate automatic deposit and manual cheque writing capabilities. This module can encompass all employee-related transactions as well as integrate with existing financial management systems.
- **Training Management**: Training programs can be entered with future dates which allow managers to track progress of employees through these programs, examine the results of courses taken and reschedule specific courses when needed. The module tracks the trainer or training organization, costs associated with training schedules. The module also tracks training locations, required supplies and equipment and registered attendees. All employees are linked to a skills profile. The skill profile lists the skills brought with them and acquired through training after they were hired. The skills profile is updated automatically through the training module.
- **Compensation Management:** Compensation Management is more than just the means to attract and retain talented employees. In today's competitive labor market,

organizations need to fully leverage their human capital to sustain a competitive position. This requires integrating employee processes, information and programs with organizational processes and strategies to achieve optimal organizational results.

- **Recruitment Management:** This module helps in hiring the right people with the right target skills. This module includes processes for managing open positions/requisitions, applicant screening, assessments, selection and hiring, correspondence, reporting and cost analysis as shown in the Fig. 4.7.9.


**Fig. 4.7.9: Hiring Process**

- **Personnel Management:** The personnel management comprises of HR master-data, personnel administration, recruitment and salary administration.
- **Organizational Management:** Organizational management includes, organizational structure, staffing schedules & job description.
- **Employee Self Service (ESS):** The employee self-service module allows employees to query HR related data and perform some HR transactions over the system. Employees may query their attendance record from the system without asking the information from HR personnel. The module also lets supervisors approve O.T. requests from their subordinates through the system without overloading the task on HR department.
- **Analytics:** The Analytics module enables organizations to extend the value of an HRMS implementation by extracting HR related data for use with other business intelligence platforms. For example, organizations combine HR metrics with other business data to identify trends and anomalies in headcount in order to better predict the impact of employee turnover on future output.

### 4.7.5 Core Banking System (CBS)

Banks can no longer continue to use legacy applications. Growth, and perhaps even endurance, depends upon an agile, cost-effective core banking solution that delivers a distinguish service know-how. Nowadays, most banks use core banking applications to sustain their operations where **CORE** stands for **"Centralized Online Real-time Environment"**.

Core banking systems are the heart of a bank. The absolute bank's branches access applications from centralized data centers. All transactions budge through core systems, which, at an absolute minimum, must remain running and responsive during business hours. Increasingly, these systems are running 24x7 to support Internet banking, global operations, and real time transactions via ATM, Internet, phone, and debit card. The various elements of core banking include:

- Making and servicing loans;
- Opening new accounts;
- Processing cash deposits and withdrawals;
- Processing payments and cheques;
- Calculating interest;
- Customer relationship management (CRM) activities;
- Managing customer accounts;
- Establishing criteria for minimum balances, interest rates, number of withdrawals allowed and so on;
- Establishing interest rates; and
- Maintaining records for all the bank's transactions.

Core Banking System may be defined as the set of basic software components that manage the services provided by a bank to its customers through its branches (branch network). In other words, the platform where communication technology and information technology are merged to suit core needs of banking is known as **Core Banking Solutions (CBS)**. These technologies have cut down time, working at the same time as on dissimilar issues and escalating usefulness. Here, computer software is developed to perform core operations of banking like recording of transactions, passbook maintenance, and interest calculations on loans and deposits, customer records, balance of payments and withdrawal.

Normal core banking functions will include deposit accounts, loans, mortgages and payments. Banks make these services available across multiple channels like ATMs, Internet banking, and branches.

Thus a core banking solution must be technologically stylish and provide future business objectives. From Fig. 4.7.10, it is clear that customer is at the initial point and Partner is at the end point. With the help of CORE Banking every services and utilities are linked with one another.

Examples of major core banking products include Infosys' Finacle, Nucleus FinnOne and Oracle's Flexcube application (from their acquisition of Indian IT vendor i-flex).

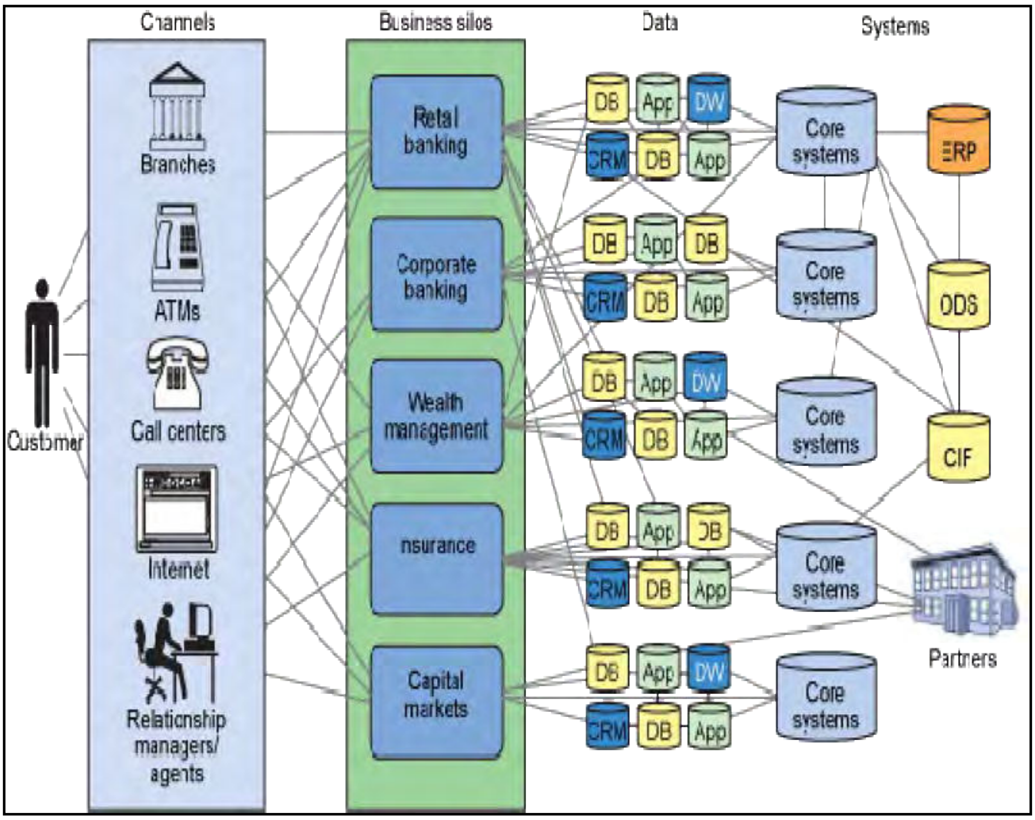


**Fig. 4.7.10: Normal Core Banking Functions***

### (A) Infosys' Finacle

Finacle core banking solution is a comprehensive, agile, componentized yet integrated business solution, addressing all the core needs of banks, in easy-to-configure modules. Finacle provides all the building blocks of business functionality enabling users to configure products and processes flexibly in order to adapt to a dynamic environment. With a 360 degree single source view into customer accounts, banks can empower customers with

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relevant information and delight them with the right offerings, presented at the right time through the right channel.

The key modules of Finacle are shown in the Fig. 4.7.11.

**(a) Enterprise customer information**: This module enables banks to create and maintain a single source of customer truth enterprise customer information files, across multiple host systems that access comprehensive segmentation information all through a unified view.

**(b) Consumer banking:** Offerings such as savings and checking accounts, and provision for personal and auto finance are easily supported. Multilayered products–structured deposits, multi-currency accounts, top-up deposits, master term deposits, top-up loans, revolving loans and securitization are added as needed.

**(c) Corporate banking:** This includes commercial lending essentials such as multicurrency disbursements and repayments, flexible and varied interest rate setup, commitment fee setup, crystallization, amortization, and debt consolidation. Finacle maintains the corporate customer information files, corporate deposits, commercial lending, corporate origination and corporate payments with comprehensive liquidity management, sweeps and pool facilities.

**(d) Trade finance:** This module presents an end-to-end solution for the trade finance needs of a bank and is fully integrated with the payment system and exchange rate setup, and supports multicurrency processing of trade products such as: documentary credit, forward contract, import and export financing, letter of guarantee, factoring and buyer's credit etc.

**(e) Customer analytics:** This module supports operations with comprehensive intelligence, ranging from data acquisition to reporting and analysis, leveraging quantitative modelling techniques and multi-dimensional reporting. There is also the flexibility to pick and choose specific customer analytics functions, relevant to the business, across the customer life-cycle stages of acquisition, development, and retention.

**(f) Wealth management**: This creates new revenue streams by offering high net worth individuals and the mass affluent, products and services powered by the Finacle wealth management solution.

**(g) Islamic banking:** This module offers a flexible and varied feature repertoire for banks to design and deploy products for varying market segments, based on different Islamic concepts. This further provides unified, comprehensive, real time view of the client across the enterprise –covering both Islamic & non Islamic Product.

**(h) Payments:** The solution manages end-to-end payments lifecycle and processes payments regardless of payment instruments, originating channels, hosting modules and payment networks.

**(i) Origination:** This module simplifies and strengthens the complete credit lifecycle, across retail and commercial loans with Finacle's enterprise loan origination solution.

**(j) Dashboards:** This provides advance operational efficiencies and user experience by enabling availability of frequently used functions on a single console.

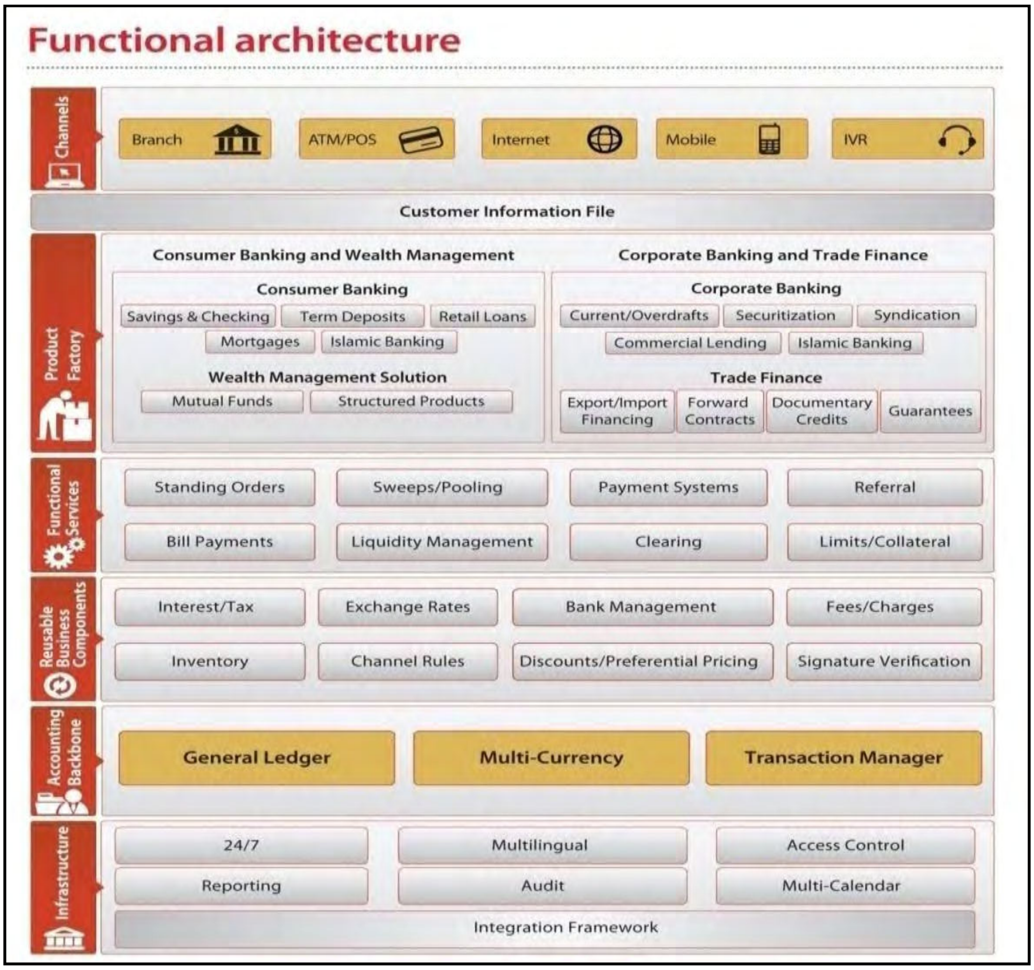


**Fig. 4.7.11: Financial Core Banking Solutions***

**(B) Nucleus FinnOne:** The Nucleus FinnOne banking suite, made and marketed by India-based Company **Nucleus software**, comes with a wide variety of integrated applications that cover different aspects of global web banking. These applications include a loan origination system that automates and manages the processing of many types of loans, a credit card application system with strong credit and fraud detection tools and a multilingual web-based collection service that organizes legal payouts.

FinnOne is a web-based global banking product designed to support banks and financial solution companies in dealing with assets, liabilities, core financial accounting and customer service. The solution is wholly focused on banking and financial services spanning across

* www.infosys.com

solutions in the areas of Retail & Corporate Banking, Cash Management, Relationship Banking, Financial CRM, Credit Risk & Appraisal, EAI, Internet Banking, FX, Basel II, Data warehousing and Analytics.

**(C) Oracle's FLEXCUBE:** Oracle FLEXCUBE helps banks transform their business model from disparate operations towards centralization of key functions, such as accounting, customer information, and management information. The centralization of operations is further augmented by role based dashboards that guide business users to take action on critical tasks, track their pending activities, and get insights into customer information and interaction. The application also provides comprehensive product processing capabilities to cater to various lines of business.

Banks using Oracle FLEXCUBE can take advantage of the high fidelity reports provided by the system for better management and operational controls. Oracle FLEXCUBE Development Workbench for Universal Banking provides the ability to create or modify products rapidly, helping banks respond quickly to market needs.

Oracle FLEXCUBE empowers universal banks with:

- Superior Web experience through self-service and assisted channels
- Improved bank staff productivity with intuitive, role-based dashboards
- Comprehensive transaction banking capabilities and Straight-Through-Processing (STP)
- Improved risk management and reporting

### 4.7.6 Accounting Information System (AIS)

*A discussion has already been introduced in the Chapter 1 "Business Process Management & IT" of the Study Material of Intermediate (IPC) Course. Some more explanation has been provided below.*

The theme of **Accounting Information System (AIS)** combines a general business background with a spotlight on Business information systems and accounting to prepare learners for specialized careers in accounting, auditing, consulting, business analysis and management. Today's accounting professionals are predictable to lend a hand organizations recognize enterprise risks and make available declaration for information systems. The principle of the majority organizations is to formulate accessible value to their customers. While "adding value" is a regularly used buzzword, in its justifiable sense, it means making the value of the finished component better than the sum of its parts. It may also connote making it prior, making it additional trustworthy, providing enhanced service or guidance, providing a bit in limited supply.

As already explained an **Accounting Information System** is defined as a system of collection, storage and processing of financial and accounting data that is used by decision makers. An Accounting Information System is generally a computer-based method for tracking accounting activity in conjunction with information technology resources. The resulting statistical reports can be used internally by management or externally by other interested parties including investors, creditors and tax authorities. Six key elements that compose the typical Accounting Information System are shown in the Table 4.7.5.

**Table 4.7.5: Key components of Accounting Information System**

| | | |
|---|---|---|
| 1 | **People** | AIS helps various system users that include accountants, consultants, business analysts, managers, chief financial officers and auditors etc. from different departments within a company to work together. With well-designed AIS, everyone within an organization who is authorized to do so can access the same system and get the same information. AIS also simplify getting information to people outside of the organization when necessary. |
| 2 | **Procedure and Instructions** | These include both manual and automated methods for collecting, storing, retrieving and processing data. |
| 3 | **Data** | Refers to the information pertinent to the organization's business practices that may include sales orders, customer billing statements, sales analysis reports, purchase requisitions, vendor invoices, check registers, general ledger, inventory data, payroll information, timekeeping, tax information etc. This data can then be used to prepare accounting statements and reports such as accounts receivable aging, depreciation/amortization schedules, trial balance, profit and loss, and so on. |
| 4 | **Software** | These are the computer programs that provide quality, reliability and security to the company's financial data that may be stored, retrieved, processed and analyzed. Managers rely on the information it outputs to make decisions for the company, and they need high-quality information to make sound decisions. |
| 5 | **Information Technology Infrastructure** | This include hardware such as personal computers, servers, printers, surge protectors, routers, storage media, and possibly a backup power supply used to operate the system. The hardware selected for AIS must be compatible with the intended software. |
| 6 | **Internal Controls** | These are the security measures such as passwords or as complex as biometric identification to protect sensitive data against unauthorized computer access and to limit access to authorized users. Internal controls also protect against computer viruses, hackers and other internal and external threats to network security. |

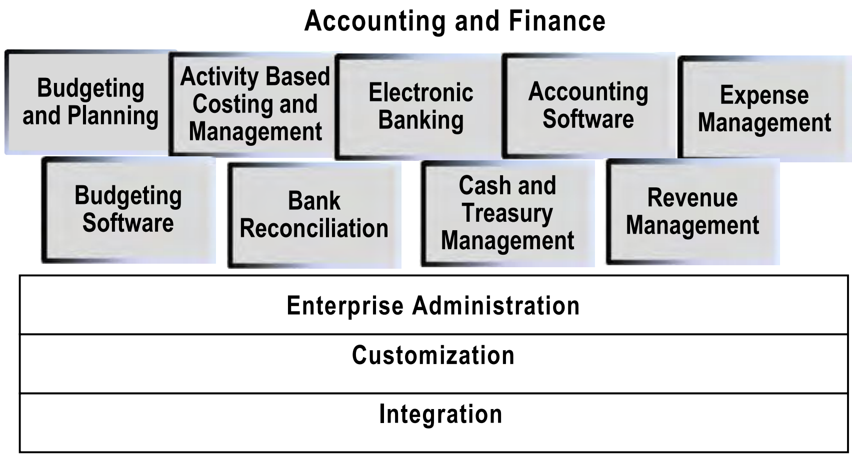


**Fig. 4.7.12: Impact of Accounting Information System**

Thus it is clear that:

- AIS are a system that brings together, records, stores, and processes data to fabricate information for decision makers.
- AIS can use extremely developed technology, be a trouble-free paper-and-pencil system, or be something in amid. Technology is just a tool to engender, uphold, or get enhanced a system.
- AIS mandate is to accumulate additionally store data about events, resources, and agents.
- Make available sufficient controls to make certain that the entity's resources (including data) are obtainable when needed, as well as truthful and dependable.
- Transform that data into information with the intention that management can exercise to make verdict about events, resources, and agents.

Accounting Information System takes into consideration different aspects, which are composed of smaller subsystems, which help an organization in achieving its goal. Accounting Information Systems offer value and is a very important part of the value chain which means making it faster, making it more reliable, providing better service or advice, providing something in limited supply, providing enhanced features or customizing it. Value is provided by performing a series of activities referred to as the value chain which includes primary activities and support activities. These activities are sometimes referred to as "line" and "staff" activities respectively.

Referring to the Fig. 4.7.12, the impact of AIS is on many areas like- Budgeting and Planning, Expenses Management, Revenue Management, Cash and Treasury Management, Accounting software, Electronic Banking, Activity-based Management, payroll, sales, purchases, invoicing, taxation, inventory management and control etc. The AIS helps in analyzing certain perspectives and helps in enhancing the performance of a company by allowing it to conduct systematic operations across the market. With the adoption and implementation of information system, an organization can focus harder on increasing its own efficiency.

## 4.8 Artificial Intelligence

**Artificial Intelligence (AI)** is the vicinity of computer science focusing on creating machines that can fit into place on behaviors that humans regard as intelligent. A significant driver for any application of artificial intelligence is fresh and innovative code. Of particular interest are ideas for powerful algorithms (or heuristics) which might be generally applicable to many applications. But we want to go a step further; to break out of the "customized program for a specific application" mindset and begin finding new ways to recycle code for new applications.

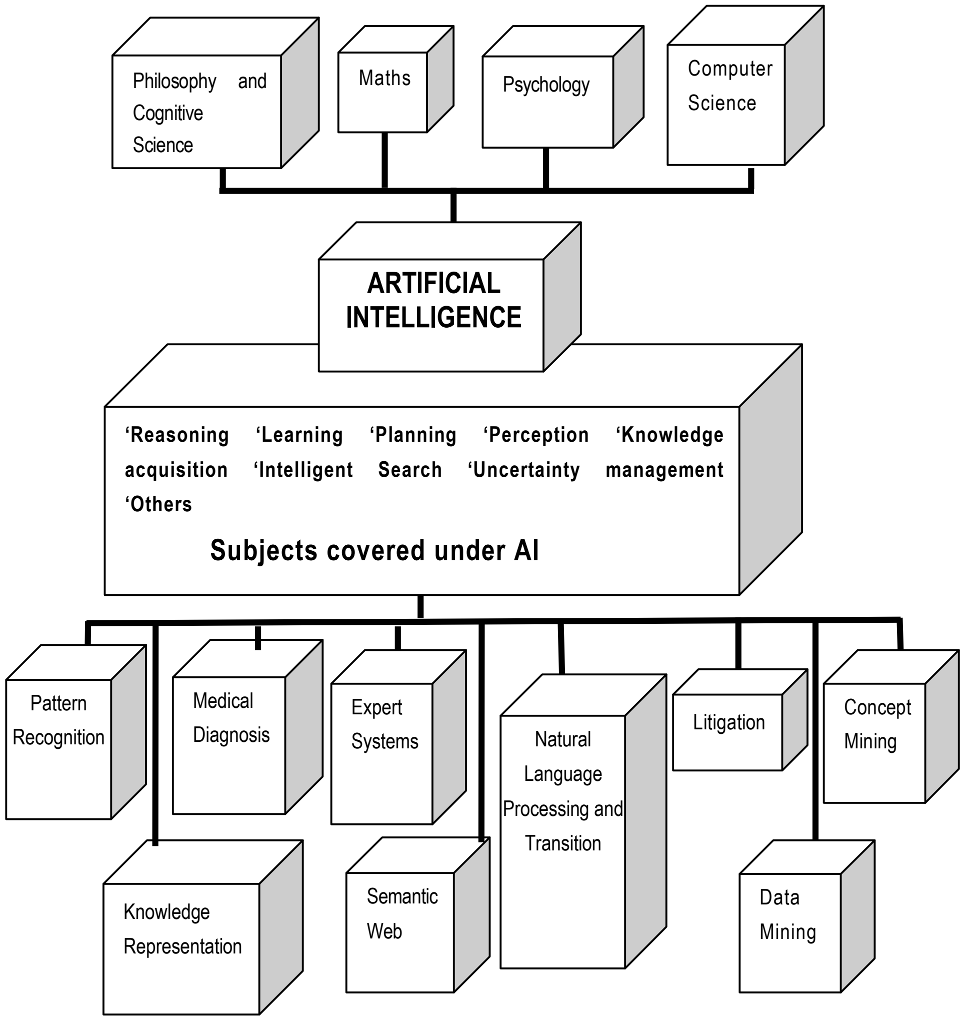


**Fig. 4.8.1: Discipline and Application Areas of AI**

**Artificial Intelligence (AI)** is a research field that studies how to comprehend the intelligent human behaviors on a computer. The decisive objective of AI is to make a computer that can discover, sketch, and crack problems in parallel. Although AI has been studied for more than half a century, we still cannot make a computer that is as intelligent as a human in all aspects. On the other hand, we do have many successful applications. In some cases, the computer outfitted with AI technology can be even more intelligent than us. The Deep Blue system which defeated the world chess champion is a well-know example.

The subject of artificial intelligence spans a wide horizon dealing with various kinds of knowledge representation schemes, different techniques of intelligent search, various methods for resolving uncertainty of data and knowledge, different schemes for automated machine learning and many others. Expert systems, Pattern Recognition, Natural language processing, and many others are some of the various purposes on which AI may be applied as shown in the Fig. 4.8.1.

Even our toaster is about to fasten together the AI revolution. We will put a bagel in it, take a photograph with the help of a smart phone, and the phone will send the toaster all the information it needs to brown it completely. In a sagacity, AI has become almost mundane ubiquitous, from the intelligent sensors that set the opening and shutter speed in digital cameras, to the heat and humidity probes in dryers, to the automatic parking feature in cars. And more applications are tumbling out of labs and laptops by the hour. Refer to the Fig. 4.8.2.

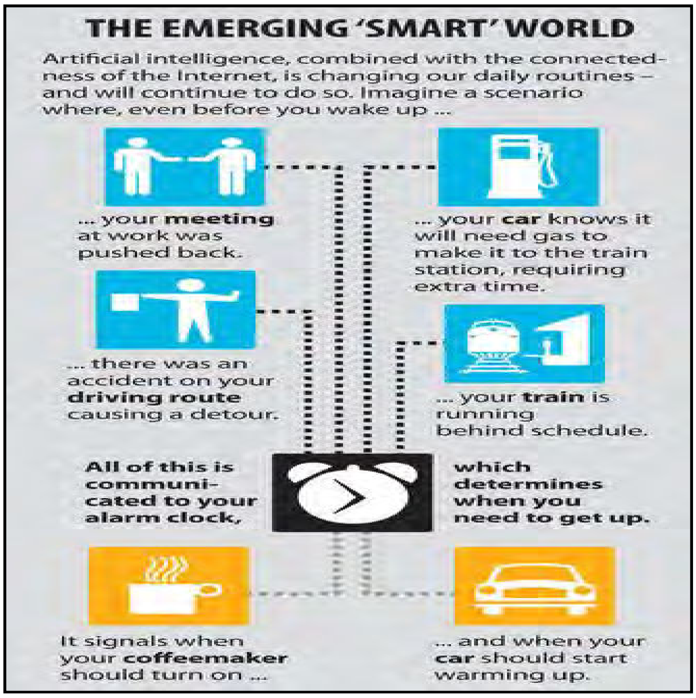


Fig. 4.8.2: AI Impact in our Day-To-Day Activity

Some of the commercial applications of AI are as follows:

**Decision Support**

- Intelligent work environment that will help you capture the "why" as well as the "what" of engineered design and decision making.
- Intelligent human–computer interface (HCI) systems that can understand spoken language and gestures, and facilitate problem solving by supporting organization wide collaborations to solve particular problems.
- Situation assessment and resource allocation software for uses that range from airlines and airports to logistics centers.

**Information Retrieval**

- AI-based Intranet and Internet systems that distill tidal waves of information into simple presentations.
- Natural language technology to retrieve any sort of online information, from text to pictures, videos, maps, and audio clips, in response to English questions.
- Database mining for marketing trend analysis, financial forecasting, and maintenance cost reduction, and more.

**Virtual Reality**

- X-ray–like vision enabled by enhanced-reality visualization that allows brain surgeons to "see through" intervening tissue to operate, monitor, and evaluate disease progression.
- Automated animation interfaces that allow users to interact with virtual objects via touch (e.g., medical students can "feel" what it's like to stitch severed aortas).

**Robotics**

- Machine-vision inspections systems for gauging, guiding, identifying, and inspecting products and providing competitive advantage in manufacturing.
- Cutting-edge robotics systems, from micro-robots and hands and legs.

## 4.9 Expert Systems

An **Expert System (ES)** is a computerized information system that allows non-experts to make decisions comparable to those of an expert. Expert Systems are used for complex or ill-structured tasks that require experience and specialized knowledge in narrow, specific subject areas. The aim of the expert system is to have a team of seasoned specialists holding industry-wide experience who further spread across implementations. Expert system has leveraged its strengths to plan and execute a miscellaneous variety of projects for Defense, Government, Finance, Telecom, and Engineering sectors. In recent years expert system facilitate in making available consulting services, displaying the self-assurance clients have in one's capability to acquire the job done right. The key components of an ES are well depicted in the Fig. 4.9.1. It is well versed that expert system takes into consideration knowledge, facts and user interface with the help of knowledge engineer to accomplish the task.

**(a) Knowledge Base:** This includes the data, knowledge, relationships, rules of thumb (heuristics), and decision trees used by experts to solve a particular problem. A knowledge base is the computer equivalent of all the knowledge and insight that an expert or group of experts develop through years of experience in their field. The knowledge base of expert systems encloses both realistic and heuristic knowledge. Realistic knowledge is that knowledge of the job domain that is extensively shared, characteristically found in textbooks or journals, and frequently agreed upon by those knowledgeable in the meticulous field whereas Heuristic knowledge is the fewer rigorous, extra empirical, supplementary judgmental knowledge of performance. In contrast to factual knowledge, heuristic knowledge is not often discussed, and is principally individualistic. It is the knowledge of high-quality put into practice, good decision, and reasonable reasoning in the field. It is the knowledge that underlies the "art of good guessing."

**(b) Inference Engine:** This program contains the logic and reasoning mechanisms that simulate the expert logic process and deliver advice. It uses data obtained from both the knowledge base and the user to make associations and inferences, form its conclusions, and recommend a course of action.

**(c) User Interface:** This program allows the user to design, create, update, use and communicate with the expert system.

**(d) Explanation facility:** This facility provides the user with an explanation of the logic the ES used to arrive at its conclusion.

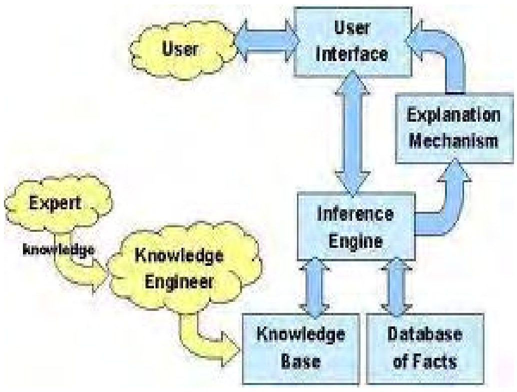


**Fig. 4.9.1: Expert System Shell**

**(e) Database of Facts:** This holds the user's input about the current problem. The user may begin by entering as much as they know about the problem or the inference engine may prompt for details or ask whether certain conditions exist. Gradually a database of facts is built up which the inference engine will use to come to a decision. The quality and quantity of data gained from the user will influence the reliability of the decision.

**Types of Expert System problem domains**

- Expert systems are designed to deal with imprecise data or problems that have more than one solution.
- Using a technique called **fuzzy logic**; an expert system can deal with imprecise data by asking for a level of confidence.
- A **neural network** uses computer circuitry to simulate the way in which a brain might process information.

Expert Systems can be **Example-based, Rule-based** or **Frame-based**.

- In **Example-based system**, developers enter the case facts and results. Through induction the ES converts the examples to a decision tree that is used to match the case at hand with those previously entered in the knowledge base.
- **Rule-based systems** are created by storing data and decision rules as if-then rules. The system asks the user questions and applied the if-then rules to the answers to draw conclusions and make recommendations. Rule-based systems are appropriate when a history of cases is unavailable or when a body of knowledge can be structured within a set of general rules.
- **Frame based systems** organize all the information (data, description, rules etc.) about a topic into logical units called frames, which are similar to linked records in data files. Rules are then established about how to assemble or inter-relate the frames to meet the user's needs.

## 4.10 Business Intelligence

In today's IT-driven society, the success of an enterprise is heavily influenced by business intelligence. Corporate giants are becoming more dependent on business intelligence software to increase the amount of knowledge they can apply in real time and reduce the cost of managing their business processes. As globalization and ICT (Information and Communications Technology) become more intertwined, the volume of data transfers among enterprises is exponentially growing.

There are many definitions of Business Intelligence (BI).

(a) BI is essentially timely, accurate, high-value, and actionable business insights, and the work processes and technologies used to obtain them.

(b) Business Intelligence (BI) is the delivery of accurate, useful information to the appropriate decision makers within the necessary time frame to support effective decision making for business processes. BI is comprised of information that contains patterns, relationships, and trends about customers, suppliers, business partners and employees. Business intelligence systems process, store and provide useful information to the user who need it, when they need it. BI can handle large amounts of information to help identify and develop new opportunities. Making use of new opportunities and implementing an effective strategy can provide a competitive market advantage and long-term stability.

(c) BI enables enterprises to harness the power of information. BI in simple words refers to the process of collecting and refining information from many sources, analyzing and presenting the information in useful ways so that users can make better business decisions.

BI has been made possible because of advances in a number of technologies, such as computing power, data storage, computational analytics, reporting and networking. BI provides an approach for solving business problems with a framework for managing tactical and strategic operations performance. From the perspective of decision-making, BI uses data about yesterday and today to facilitate making better decisions about tomorrow. This is done through various means such as selecting the right criteria to judge success, locating and transforming the appropriate data to draw conclusions, or arranging information in a manner that best provides insights into the future thus making enterprise to work smarter. BI enables managers to see things with more clarity, and empowers them to peek into the possible future.

### 4.10.1 Business Intelligence Tools

Business Intelligence tools are a type of software that is designed to retrieve, analyze and report data. BI is basically just getting important business information to decision makers when they need it – in a way that they can actually use it. Business Intelligence tools are standalone tools or suites of tools that are targeted to a specific industry that implement a particular BI technique.

Business Intelligence tools are software programs and features that are used to complete detailed data analysis. There are different types of business intelligence tools which a business may need in order to achieve business objectives. Some of the key Business Intelligence tools are given as follows:

- **Simple Reporting and Querying:** This involves using the data warehouse to get response to the query: “Tell me what happened.” The objective of a BI implementation is to turn operational data into meaningful knowledge. This requires that BI must be connected with the enterprise data and all the necessary data is available in one place, in one common format. Data warehousing (DW) provides the perfect architecture to combine all the data dispersed throughout the enterprise in different applications in a variety of formats, on a range of hardware, which could be anywhere to be cleaned up, summarized, converted and integrated into one common format and available centrally for further processing. There are reporting tools used to arrange information into a readable format and distribute it to the people who need it.
- **Business Analysis:** This involves using the data to get response to the query: “Tell me what happened and why.” Business analysis refers to presenting visualizing data in a multidimensional manner. Query and report data is presented in row after row of two-dimensional data. Typically, the first dimension is the headings for the data columns and the second dimension is the actual data listed below those column headings.

Business analysis allows the user to plot data in row and column coordinates to further understand the intersecting points. **ETL** (**Extract, Transform, Load)** tools bring in data from outside sources, transform it to meet business specified operational needs, and then load the results into the company database. Metadata tools tools gather and analyze metadata, helping to increase data quality.

- **Dashboards:** This involves using the information gathered from the data warehouse and making it available to users as snapshots of many different things with the objective of getting response to the query: "Tell me a lot of things, but without too much effort". Dashboards are flexible tools that can be bent into as many different shapes as per user requirements. It includes a collection of graphs, reports, and KPIs that can help monitor such business activities as progress on a specific initiative.
- **Scorecards**: This involves providing a visual representation of the enterprise strategy by taking critical metrics and mapping them to strategic goals throughout the enterprise. Scorecards offer a rich, visual gauge to display the performance of specific initiatives, business units, or the enterprise as a whole and the individual goals in the context of larger enterprise strategy. Scorecards distil information into a small number of metrics and targets and provide users with an at-a-glance perspective of information. A scorecard has a graphical list of specific, attainable strategic milestones, combined with metrics that serve as benchmarks. Specific measures on how well the company has actually performed specified activities are linked in the scorecard with graphical display highlighting the status of each goal.
- **Data Mining or Statistical Analysis:** This involves using statistical, artificial intelligence, and related techniques to mine through large volumes of data and providing knowledge without users even having to ask specific questions. The objective is to provide interesting and useful information to users by design even without their querying. Data Mining involves data analysis for discovering useful patterns that are "hidden" in large volume of diverse data. For Example: Market segmentation - identify common characteristics of customers who buy same products. OLAP (Online Analytical Processing) is a multi-dimensional analytical tool typically used in data mining, that gathers and process vast amounts of information into useful packets.

### 4.10.2 Business Reporting through MIS and IT

Prior to talking about business reporting in an MIS and IT perspectives it would be justified if we throw a light on the term business reports. Business reports are a type task which facilitates in scrutinizing a situation (either a real life scenario or a case study) and pertain to business theories to fabricate a variety of suggestions for development.

Reporting has been of significance to businesses by providing a platform for users to get immediate access to business information by using simple analysis. However, Business Intelligence (BI) caters to strategic, tactical and operational needs; providing a platform for complete, comprehensive performance management for today's global, competitive businesses. Business reports are routinely assigned to facilitate us to:

- Accomplish conclusions about a trouble or issue.
- Demonstrate short and apparent communication skills.
- Endow with recommendations for upcoming accomplishing.
- Exhibit our analytical, reasoning, and evaluation skills in identifying and weighing-up potential solutions and outcomes.
- Pertain business and management theory to a practical situation.
- Scrutinize obtainable and potential solutions to a problem, situation, or question.

Business reporting or enterprise reporting is a primary division of the bigger movement towards enhanced business intelligence and knowledge management. Business reporting or enterprise reporting is a primary division of the bigger movement towards enhanced business intelligence and knowledge management. Over and over again, realization involves any of aforementioned tools in coordination with a data warehouse and then using one or more reporting tools. While reports can be distributed in print form or via email, they are characteristically accessed via a corporate intranet.

While analyzing the business reports, classically, there is no thumb rule to reach a conclusion but numerous solutions, each associated with their own costs and benefits to an organization. It is these costs and benefits which one needs to recognize and compare in any report. However, Business Reports streamline any business's concerns and helps in taking smarter decisions and increase the productivity.

**Benefits for micro-businesses and small to medium enterprises**

- **Paperless lodgment -** Eliminates the hassle of paper work and associated costs;
- **Electronic record keeping** – Stores the reports securely in the accounting or bookkeeping system;
- **Pre-filled forms -** Reports are automatically pre-filled with information existing in the accounting or bookkeeping system, as well as from information held by government, saving valuable time;
- **Ease of sharing** – Sharing between client, accountant, tax agent or bookkeeper for checking;
- **Secure AUSkey authentication** - AUSkey is a common authentication solution for business-to-government online services.
- **Same-time validation -** receive a fast response that any lodgment has been received.

**Benefits for large business**

- A **single reporting language** to report to **government**: **eXtensible Business Reporting Language (XBRL)** - an international standards-based business reporting language developed by accountants for financial reporting;

- **Reduce costs** - reduction in the cost of assembling, analyzing, and providing data to government;
- **Streamline the process of aggregating data** - Opportunities exist for streamlining the process of aggregating data across different internal departments, or business units of a company;
- **Increased access to comparable performance information** – Standard Business Report (SBR) uses the same standard (XBRL) that simplifies and adds integrity to the performance of capital market comparisons by analysts and investors;
- **Secure AUSkey authentication** - lodge online securely to a range of government agencies; and
- **Same-time validation** - rapid response that any lodgment has been received.

## 4.11 Importance of Access and Privilege Controls

In order to safeguard software systems, procedures are developed and implemented for protecting them from unauthorized modification, disclosure or destruction to ensure that information remains accurate, confidential, and is available when required. The administration of users' access to the software applies the principles of least privilege and "need to know" basis. Logical access level to software and information are restricted to users authorized by the respective Security Administrator. Access controls help us to restrict whom and what accesses our information resources, and they possess four general functions: identity verification, authentication, authorization, and accountability. These functions work together to grant access to resources and constrain what a subject can do with them. These are discussed as follows:

- **Identity Management:** Identity management consists of one or more processes to verify the identity of a subject attempting to access an object. However, it does not provide 100 percent assurance of the subject's identity. Rather, it provides a level of probability of assurance. The level of probability depends on the identity verification processes in place and their general trustworthiness. Identity management has become a separate consideration for access control. However, the three pillars that support authorized access still define the tools and techniques necessary to manage who gets access to what and what they can do when they get there: authentication, authorization, and accountability.
- **Authentication:** Identity management and authentication are inseparable. Identity management includes assigning and managing a subject's identity. Authentication is the process of verifying a subject's identity at the point of object access.
- **Authorization:** Once a resource or network verifies a subject's identity, the process of determining what objects that subject can access begins. Authorization identifies what systems, network resources, etc. a subject can access. Related processes also enforce

least privilege, need-to-know, and separation of duties. Authorization is further divided into coarse and fine dimensions.

- **Accountability:** Each step from identity presentation through authentication and **authorization** is logged. Further, the object or some external resource logs all activity between the subject and object. The logs are stored for audits, sent to a log management solution, etc. They provide insight into how well the access control process is working: whether or not subjects abuse their access.

### 4.11.1 Approaches to Access Control

There are two major approaches to establish access controls, which are given as under:

- **Role-based Access Control (RBAC):** RBAC largely eliminates discretion when providing access to objects. Instead, administrators or automated systems place subjects into roles. Subjects receive only the rights and permissions assigned to those roles. When an employee changes jobs, all previous access is removed, and the rights and permissions of the new role are assigned.
- **Rules-based Access Control (RAC):** RAC differs from RBAC methods because it is largely context-based. RBAC, for example, enforces static constraints based on a user's role. RAC, however, also takes into account the data affected, the identity attempting to perform a task, and other triggers governed by business rules. A manager, for example, has the ability to approve his/her employees' hours worked. However, when s/he attempts to approve his/her own hours, a rule built into the application compares the employee record and the user, sees they are the same, and temporarily removes approval privilege. Note that this is dynamic and occurs at the time a transaction is attempted. This also sometimes called dynamic RBAC.

### 4.11.2 Principle of Least Privilege

This is a fundamental principle of information security, which refers to give only those privileges to a user account, which are essential to that user's work. For example, a backup user does not need to install software; hence, the backup user has rights only to run backup and backup-related applications. Any other privileges, such as installing new software, should be blocked. The principle applies also to a personal computer user, who usually does work in a normal user account, and opens a privileged, password protected account (that is, a super user) only when the situation absolutely demands it.

When applied to users, the terms Least User Access or Least-privileged User Account (LUA) are also used, referring to the concept that all user accounts at all times should run with as few privileges as possible, and also launch applications with as few privileges as possible. Software bugs may be exposed when applications do not work correctly without elevated privileges. The principle of least privilege is widely recognized as an important design consideration in enhancing the protection of data and functionality from any kind of compromises towards security.

## 4.12 Payment Mechanisms

e-Commerce will have a direct bearing on the validity of the information to individuals, corporations or the country's economic interests and reputation. The validity of the transaction price, period, and the number of hours as part of the agreement is particularly vital.

The use of a credit card as a payment mechanism augments the tendency to spend as compare to cash in otherwise identical purchase situations. Consumers nowadays have the prospect to pay for transactions with a progressively more growing array of payment mechanisms. In addition to conventional mode of payments like cash and cheques, the past few years have seen the speedy creation of plastic payment mechanisms - credit cards, charge cards and debit cards. In addition, consumers are also identifiable with payment mechanisms like traveler's checks, credit checks and money orders. Over the coming years, a total new generation of payment mechanisms like smart cards, memory cards and electronic payments is expected to cultivate and in due course symbolize a remarkable proportion of all consumer transactions.

With the increase in online shopping and e-commerce industry, it has now become a requirement that the web stores are integrated with a payment gateway. Payment gateway is fundamentally a service used to process credit card transactions when orders are accepted online from clients. In a way, it represents a physical **POS (Point-of-sale)** terminal, which is set in every retail outlet these days. Payment gateways use a special code for acquiring sensitive information like credit card numbers, so that information passes securely.

The Fig. 4.12.1 shows once the order is placed, the bank is used to transfer fund using net banking. Online electronic payments are not corresponding to electronic payments. In the emergence of e-commerce, credit cards have long been represented by electronic means of payment, credit cards in shopping malls. Many hotels and other places and items could swipe of the card, POS terminals Regulations, ATM cash forms of payment.

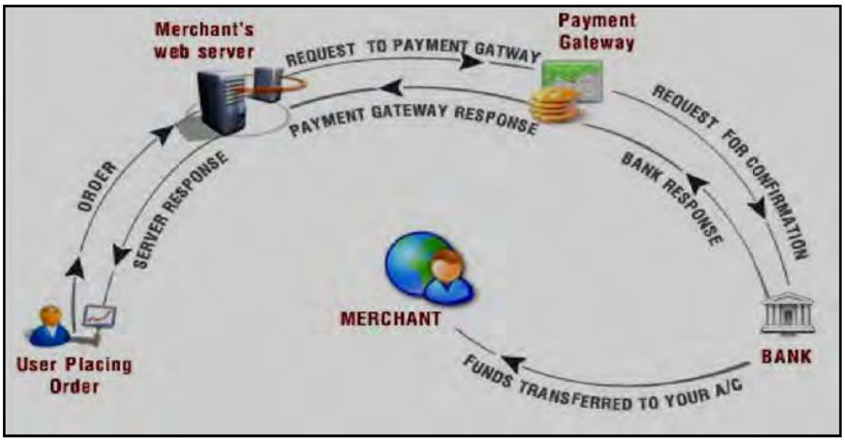


**Fig. 4.12.1: Payment Gateways**

**Major types of Electronic Payments**

In general, the integration of the payments process appears to be important ingredient for both businesses and regulators. Since we are here to discuss the chapter which revolves around BIS; thus the payment mechanism will be considered in terms of online. Here on-line e-commerce transaction involves more than just a financial transaction; it is also called 'Whole Transaction Processes'. Some of the Electronic payments modes are as follows: (Refer Fig. 4.12.2):

**Fig. 4.12.2: Swipe Cards through POS and ATM**

**A. Credit Cards**: In a credit card transaction, the consumer presents preliminary proof of his ability to pay by presenting his credit card number to the merchant. The merchant can verify this with the bank, and create a purchase slip for the consumer to endorse. The merchant then uses this purchase slip to collect funds from the bank, and, on the next billing cycle, the consumer receives a statement from the bank with a record of the transaction.

**How a Credit Card is processed?**

**Step 1: Authorization** – This is the first step in processing a credit card. After a merchant swipes the card, the data is submitted to merchant's bank, called an acquirer, to request authorization for the sale. The acquirer then routes the request to the card-issuing bank, where it is authorized or denied, and the merchant is allowed to process the sale.

**Step 2: Batching** – This is the second step in processing a credit card. At the end of a day, the merchant reviews all the day's sales to ensure they were authorized and signed by the cardholder. It then transmits all the sales at once, called a batch, to the acquirer to receive payment.

**Step 3: Clearing** – This is the third step in processing a credit card. After the acquirer receives the batch, it sends it through the card network, where each sale is routed to the appropriate issuing bank. The issuing bank then subtracts its interchange fees, which are shared with the card network, and transfers the remaining amount through the network back to the acquirer.

**Step 4: Funding** –This is the fourth and final step in processing a credit card. After receiving payment from the issuer, minus interchange fees, the acquirer subtracts its discount fee and sends the remainder to the merchant. The merchant is now paid for the transaction, and the cardholder is billed.

Using a credit card to make a purchase over the Internet follows the same scenario. But on the Internet, added steps must be taken to provide for secure transactions and authentication of both buyer and seller. To address these growing security concerns and pave the way for uninhibited growth of electronic commerce on the net, the two leading credit card brands, Visa and MasterCard, teamed up some years ago to develop a common standard to process card transactions on the Internet, called the Secure Electronic Transaction (SET) standard.

**B. Electronic Cheques**

Credit card payments will undoubtedly be popular for commerce on the Internet. However, following two systems have been developed to let consumers use electronic cheques to pay Web merchants directly.

(a) **By the Financial Services Technology Corporation (FSTC):** The FSTC is a consortium of banks and clearing houses that has designed an electronic cheque. Modeled on the traditional paper cheque, this new cheque is initiated electronically, and uses a digital signature for signing and endorsing. To add to the flexibility of their payment system, the FSTC wants to offer users a choice of payment instruments that allow them to designate an electronic cheque as a certified cheque or an electronic charge card slip. This means that the user can use a single mechanism, the electronic cheque, to complete payments that vary according to payee's requirements.

(b) **By CyberCash**: An electronic cheque has all the same features as a paper cheque. It functions as a message to the sender's bank to transfer funds, and, like a paper cheque, the message is given initially to the receiver who, in turn, endorses the cheque and presents it to the bank to obtain funds. The electronic cheque can prove to be superior to the paper cheque in one significant aspect. As sender, we can protect ourselves against fraud by encoding our account number with the bank's public key, thereby not revealing our account number to the merchant. As with the SET protocol, digital certificates can be used to authenticate the payer, the payer's bank, and bank account.

**C. Smart Cards**

Smart cards have an embedded microchip instead of magnetic strip. The chip contains all the information a magnetic strip contains but offers the possibility of manipulating the data and executing applications on the card. Three types of smart cards are as follows:

- **Contact Cards –** Smart cards that need to insert into a reader in order to work, such as a smart card reader or automatic teller machines.
- **Contactless Cards** – Contactless smart cards don't need to be inserted into a reader. Just waving them near a reader is just sufficient for the card to exchange data. This type of cards is used for opening doors.
- **Combi/Hybrid Cards –** Combi cards contain both technologies and allow a wider range of applications.

**D. Electronic Purses**

Electronic Purse Card is yet another way to make payments over the net. It is very similar to a pre-paid card. For example: Bank issues a stored value card to its customer, the customer can then transfer value from his/her account to the card at an ATM, a personal computer, or a specially equipped telephone. The electronic purse card can be used as an ATM card as well as a credit card.

While making purchases, customers pass their cards through a vendor's point of sale terminal. No credit check or signature is needed. Validation is done through a Personal Identification Number (PIN Number).

Once the transaction is complete, funds are deducted directly from the cards and transferred to the vendor's terminal. Merchants can transfer the value of accumulated transactions to their bank accounts by telephone as frequently as they choose. When the value on a card is spent, consumers can load additional funds from their accounts to the card.

**A typical On-line transaction**

The below mentioned Fig. 4.12.3 shows that the online e-commerce transaction is composed of three main functions: sales, payment and delivery. The Figure depicts how the payment is viewed as a part of an on-line transaction.

**Terminology used in figure and certain sub-functions:**

- **Advertising:** The company communicates its products and services (catalogue);
- **Offering:** The company offers specific goods and services;
- **Selling:** The company agrees with the customer on the content of a specific order;
- **Billing:** The company produces the invoice;
- **Paying:** The buyer pays the seller by giving a payment instruction;
- **Matching:** The seller matches the payment information (the authorization results and the actual crediting of account) with the orders and feeds the result into the back-office;
- **Delivering:** The seller delivers to the buyer; and
- **Resolving:** The seller and buyer try to resolve delivery or payment issues related to the purchase.

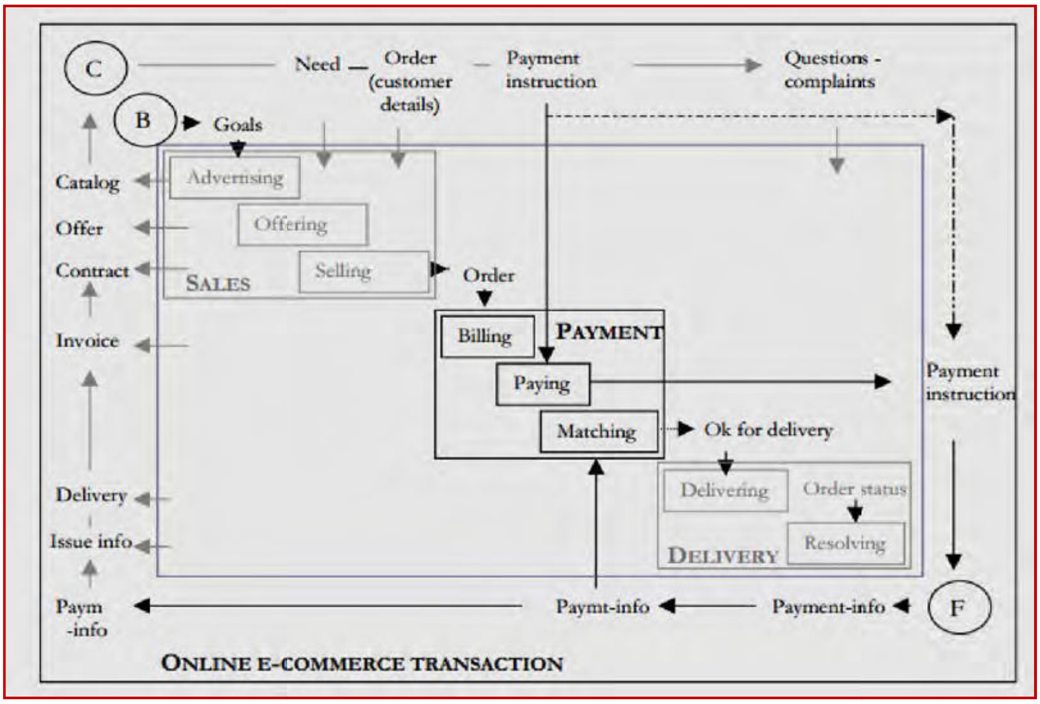


**Fig. 4.12.3: Functional model of the online e-commerce transaction**

However, in some cases, the payment can also be a separate off-line transaction or a transaction via a financial intermediary (depicted by the dotted line). The current payment instruments for use on the web have different characteristics in terms of risk and security.

## 4.13 Summary

In the present contemporary world, apart from change the thought-provoking terminology is business which is a driving force behind change and how to insight into trade is a dynamics called integration. Organizations of the 1990's concentrated on the reengineering and redesign of their business processes in order to endorse their competitive advantage. In order to endure in the 21st century, organizations have started paying attention on integrating enterprise-wide technology solutions in an effort to progress their business processes called Business Information Systems (BIS). At the moment, more or less every organization integrates part or all of its business functions together to accomplish higher effectiveness and yield. The thrust of the argument was that Information Technology (IT), when skillfully employed could in various ways differentiate an organization from its competition, add value to its services or products in the eyes of its customers, and secure a competitive advantage in comparison to its competition.

# 5

# Business Process Automation through Application Software

| Learning Objectives |
|---|
| ♦ To understand business applications and the basis for their classification; |
| ♦ To understand how to go about automation of critical business processes; |
| ♦ To identify the need for automation of information processing cycles; |
| ♦ To understand the need for adopting effective delivery channels based on user needs; |
| ♦ To understand functioning of Application Controls; and |
| ♦ To have an overview of the key Emerging Technologies and their usage. |
| **Task Statements** |
| ♦ To identify various types of business applications according to their usage; |
| ♦ To identify critical business processes, which can be automated and assess the impact of business process automation; |
| ♦ To distinguish between computerized information processing and manual information processing; |
| ♦ To assess the impact of the choice of delivery channels on business decision making; |
| ♦ To assess the risk of having poor controls and areas where they are needed to be deployed; and |
| ♦ To identify opportunities for resource optimization using new technologies like Virtualization, Grid Computing and Cloud Computing. |
| **Knowledge Statements** |
| ♦ Knowledge of various types of business applications that have been developed to automate business processes across varied industries; |
| ♦ Knowledge of the steps involved in business process automation, the applications that enable automation and the relevant controls; |
| ♦ Knowledge of different types of information processing cycles and the current trends; |

- Knowledge of various types of delivery channels and how they impact business decision making;
- Knowledge of various types of application controls, the functions they perform and the way they are deployed; and
- Knowledge of the working of new technologies like Virtualization, Grid Computing and Cloud Computing.

## 5.1 Introduction

Information Technology (IT) is an exciting avenue where massive investments are being made and the impact on its deployment will not only affect the way enterprises operate and provide their services but it will also influence the way business will be done in the near future. IT will open out new vistas of commerce breaking all barriers and boundaries. This has made the concept of "Geography is History" as true. The rapid growth in communication technology making it faster and reliable coupled with its integration with IT has truly made the world today a global village making true the concept, "The Network is the Computer". With network availability, there are really no barriers or boundaries. Any enterprise located in any remote corner can make their products or services available to anyone, anywhere at any time.

The speed of automation of all activities, whether they be connected to business or not directly connected to business, has surprised the stakeholders of enterprises, who are affected by such computerization. The changing dynamics of business due to this automation has forced management to re-think their strategy to stay in business. Today the speed with which automation has occurred, the extent of automation and the dependency on automation for ensuring enterprise success is one of the key challenges for enterprises to survive and thrive in the global digital age.

We find pervasiveness of automation in every aspect of our daily life whether it is personal or professional. The day starts with delivery of newspaper; the delivery boy has used Google maps to chart his/her path to our house. The milkman: AMUL, uses high degree of technology to ensure that we get the freshest milk. Next on the list is the vegetable vendor, which is now the nearby departmental stores selling vegetables using technology for all their key operations right from procurement to stock replenishment. The kids going to school find that their test scores are being emailed or sent by SMS to their parents. In higher educational institutions, if a student is absent, the system directly sends an automated SMS to parents of the child.

In our professional work, we realize that our daily job has changed, due to use of technology. Now, few routine jobs are expected to be done by an employee but are taken care by automated systems. For example: attendance marking and tracking. Many office automation systems have reduced the manual jobs, as they can be easily done by computer systems. Indian citizens need not go to government offices to deposit taxes, or pay utility bills; everything has been made available online. Commercial establishments have all automated their processes, like banks, share markets, insurance companies, etc. The level of automation has helped our country to progress faster and helped businesses to save costs.

Governments at both Central and State level have embarked upon large IT enabled service programs to using e-governance model. Now, virtually every tax department in country is computerized. The level of computerization has now started trickling down to municipal corporations with many municipalities in India enabling citizens to pay municipal taxes online.

The level of computerization and the acceptance of the same in the country has not only changed the way enterprise provide products and services but also it has changed the way people are performing regular tasks. For example, people are not reading books but reading e-books. People do not go to nearby mall to buy a product but buy the same online at the convenience of home/office and at any time during the day/night. The delivery channels have changed from physical to e-mode, by delivery of information or goods.

However, the level of automation needs to be controlled considering the inherent risks of technology. This makes it imperative to implement the adequate level of appropriate controls during all stages of computer processing right from the data capture to the data storage phase. It is important to process the information effectively and efficiently and at the heart of this information processing is IT. Business value is derived by making information available to all stakeholders but also ensuring security of this information.

New technologies are getting developed due to large scale computerization, decreasing costs of storing data and increasing speed of internet. Emerging technologies such as virtualization, grid computing and cloud delivery model are enabling technology revolution version 2. It is basically application of technology revolution version 1, where large scale networking created a huge network of computers called as Internet.

## 5.2 Classification of Business Applications

The meaning of Business Application can be best understood by dividing the set of words into their constituents. **Business** is defined as a person's regular occupation or commercial activity, a person's concern. **Application**, in terms of computers, is defined as a computer program to fulfill a particular purpose. Bringing together these definitions shall define the word **Business Application** as a computer program used to fulfill a person's need for regular occupation or commercial activity.

This means that business applications are software or set of software used by business people. The next step is to understand the business needs, which can be fulfilled through the software. These can be all activities to run business, like keeping track of inventory levels, checking for bank account balances, checking status of delivery of goods dispatched, and all other business activities.

Business applications can be classified based on various usages they are put to as well as user's understanding of the application. A typical classification is shown in Table 5.2.1.

Table 5.2.1: Classification of Business Applications

| Types | Nature of processing | Source of application | Size and Complexity of business | Nature of Application |
|---|---|---|---|---|
| Type I | Batch Processing | Custom built | Small business | Accounting application |
| Type II | Online Processing | Packaged software | Medium business | Cash Management |
| Type III | Real-time Processing | Leased | Large business | Manufacturing Applications |
| More types | No | Yes | No | Yes |
| Students need to understand that business applications by their nature can vary numerously. While there are various models and categorizations of these business applications; the classifications are not consistent and the above categorization is a just a sample way of classifying them. Above list is only illustrative; students are expected to use their intelligence to add further items to above list. . | | | | |

Classification is an effort to categorize numerous types of business applications on a logical basis. Let us understand the basis of the above classification.

### 5.2.1 Applications based on Nature of Processing

This is the way an application updates data, say in batch processing, there is a time delay in occurrence and recording of transaction. On the other hand in online processing, the transactions are recorded at the moment they occur. An application that allows query handling/ responses to updates in system is classified as real time processing system.

- **Batch Processing:** It is defined as a processing of large set of data in a specific way, automatically, without needing any user intervention. The data is first collected, during a work day, for example, and then batch-processed, so all the collected data is processed in one go. This could happen at the end of the work day, for example, when computing capacities are not needed for other tasks. It is possible to perform repetitive tasks on a large number of pieces of data rapidly without needing the user to monitor it. Batched jobs can take a long time to process. Batch processing is used in producing bills, stock control, producing monthly credit card statements, etc.
- **Online Processing:** Data is processed immediately while it is entered, the user usually only has to wait a short time for a response. (Example: games, word processing, booking systems). Interactive or online processing requires a user to supply an input. Interactive or online processing enables the user to input data and get the results of the processing of that data immediately.

- **Real-time Processing:** Real time processing is a subset of interactive or online processing. Input is continuously, automatically acquired from sensors, for example, which is processed immediately in order to respond to the input in as little time as possible. After the system is finished responding, it reads the next set of input data immediately to process that. This system doesn't need a user to control it, it works automatically. Whenever there is a rapid reaction required due to some sort of change, real time processing can take action without the need of a user or long processing time beforehand. Real time processing is used in warning systems on aircraft, alarm systems in hazardous zones, burglar alarms etc.

### 5.2.2 Applications based on Source of Application

The name of category is self-explanatory, as it tells the source from where application has been bought.

- **Custom-built Application:** Whether they are for one function or integrate processes across the company like an ERP – these are the easiest ones to customize. These applications can however be configured to meet a particular company's requirements. Customization involves additional coding while configuration is based on settings which are inputted by the user. Example – Billing, Inventory, Attendance etc.
- **Packaged Software:** These are the standard applications which are not free but are licensed. Customization to suit business requirements may or may not be allowed. For Example -Tally, Oracle 9i, etc.
- **Leased application:** A new method for getting applications is being used today, i.e. leased applications, where user pays fixed rent for using the application for agreed terms. Many specialized vendors provide users with option to get their job done by paying monthly rent; this is referred to as outsourcing.

### 5.2.3 Applications based on Size and Complexity of Business

This classification is based on the users for whom the application has been developed. Here, the emphasis is on size and complexity of business process. This categorization is again important, as it denotes the basic purpose of any business application.

- **Small and Medium Enterprise (SME) business:** The best software for small and medium businesses is software designed to help them to run their operations better, cut costs and replace paper processes. The most popular software packages include accounts, office productivity, email and communications, but nowadays, most business activities can be improved through desktop or web-based applications.
- **Large Business:** When it comes to other sorts of business software, designed for the larger or more ambitious businesses, a business application being used by a large number of small business establishments in India may not be effective for large business organizations. The business tools that tend to be favored by larger businesses include CRM, for recording customer information and finding out trends in buying habits; and

sales force automation, which helpful for organizing and managing sales teams and leads. Business may also choose to use human resources software; business intelligence and dashboard tools; database management systems; and enterprise resource planning and supply chain management tools.

However, these may not be for everyone and can add cost and complexity to small businesses' IT systems.

### 5.2.4 Business applications based on Nature of Application

It is clear from the above discussion that the categorization can be extended based on an individual's understanding and perception of application under review. A business application may also be classified based on business function it covers. For example - accounting applications, Office Management software, Compliance application, Customer relationship management, Decision making software, ERP software, Product lifecycle management, etc.

- **Accounting Applications:** Accounting applications range from application software such as TALLY and wings to high-and applications such as SAP and Oracle Financials. These are used by business entities for the purpose of day-to-day transactions of accounting and generating financial information such as balance sheet, profit and loss account and cash flow statements. These are classified as accounting applications.
- **Office Management Software:** These applications help entities to manage their office requirements like word processors (MS Word), electronic spreadsheets (MS Excel), presentation software (PowerPoint), file sharing systems, etc. The purpose is to automate the day-to-day office work and administration.
- **Compliance Applications:** Enterprises need to comply with applicable laws and regulations. India has taken a long stride in adopting e-compliance for its citizens with government promoting e-filing of documents, e-payments taxes, e-storage of data, etc. This has raised the requirements for software which can help any entity achieve compliances. A separate class of business application are available that facilitate meeting the compliance requirements.
- **Customer Relationship Management Software:** These are specialized applications catering to the need of organizations largely in **FMCG (Fast-Moving Consumer Goods)** categories. These entities need to interact with their customers and respond to them. The response may be in the form of service support or may lead to product innovation. These are sought by entities, which deal directly with consumers.
- **Management Support Software:** These are applications catering to decision-making needs of the management. They may be further classified based on the level of management using them. For example, Management Information System are generally used by middle level manager's for their decision making needs, on the other hand Decision Support Systems are used by top management for their information requirements.

- **ERP Software:** These applications called as Enterprise Resource Planning software, which are used by entities to manage resources optimally and to maximize the three Es i.e. Economy, Efficiency and Effectiveness of business operations.
- **Product Lifecycle Management Software:** These business applications are used by enterprises that launch new products and are involved in development of new products. The recent trend in auto-sector in India reflects the growing importance and need of this type of software. Each month a new product is launched by auto companies in India, may it be two-wheeler or four-wheeler segment. The top management of all these companies often say that “the life cycle of auto products have significantly reduced”.
- **Logistics Management Software:** For large logistics managing companies, these are key business applications. These companies need to keep track of products and people across the globe to check whether there are any discrepancies that need action.
- **Legal Management Software:** In India, a lot of effort is being put to digitize the legal system. Government of India, is keen to reduce the pendency in courts. As this process goes on legal profession in India shall need such systems. There are big legal firms in India, which are already using such business applications.
- **Industry Specific Applications:** These are industry specific applications focused on a specific industry sector. For example, software designed especially for Banking applications, Insurance applications, Automobile dealer system, billing systems for malls, Cinema ticketing software, Travel industry related software, etc.

## 5.3 Business Process Automation

**Business Process Automation (BPA)** is a strategy that is used to optimize and streamline the essential business processes, using the latest technology to automate the functions involved in carrying them out. The idea behind BPA is to allow the organizations to extract maximum benefit by using the available resources to their best advantage, while keeping the operational cost as low as possible. Doing so helps the enterprise to generate greater profits and achieve a level of stability that would be hard to realize without the use of automation.

BPA capabilities range from automating a simple data-entry-manipulation task to building complex, automated financial management processes using existing applications.

### 5.3.1 Objectives of BPA

The success of any business process automation shall only be achieved when BPA ensures the following:

- **Confidentiality:** To ensure that data is only available to persons who have right to see the same;
- **Integrity:** To ensure that no un-authorized amendments can be made in the data;
- **Availability:** To ensure that data is available when asked for; and

- **Timeliness:** To ensure that data is made available in at the right time.

  To ensure that all the above parameters are met, BPA needs to have appropriate internal controls put in place. A more detailed discussion follows in later sections of the chapter.

### 5.3.2 Why BPA?

BPA is the basic component of an enterprise-wide automation and management scheme for both business and IT workflow. With BPA, we can optimize and streamline our business processes by automating the process components. By improving the performance, accuracy and efficiency of the key business processes, the enterprise is made more efficient and responsive to customer and employee needs. Some benefits of pursuing such automation include the following:

- **Reducing the Impact of Human Error**: BPA removes human participation in the process, which is the source of many errors.
- **Transforming Data into Information**: BPA can, apart from collecting and storing data also analyze data and make it available in a form that is useful for decision-making.
- **Improving performance and process effectiveness**: In many cases, tasks that must be done manually are the bottleneck in the process. Automating those manual tasks speeds up the effective throughput of the application.
- **Making users more efficient and effective**: People can focus their energies on the tasks they do best, allowing the computers to handle those that machines are best suited for.
- **Making the business more responsive**: Enterprises can easily automate new applications and processes as they are introduced that provide greater control over business and IT processes.
- **Improving Collaboration and Information Sharing**: Business processes designed through a collaborative interface mean IT can integrate its processes with the business-side logic that drives day-to-day operations.
- **Cost Saving**: Automation leads to saving in time and labor costs through higher efficiency and better management of the people involved;
- **To remain competitive**: To provide the level of products and services as offered by competition.
- **Fast service to customers**: Automation shortens cycle times in the execution of processes through improved and refined business workflows and help enterprises to serve their customers faster and better.

| Case Study |
|---|
| **The following case study offers interesting insights on the benefit of BPA:** |
| Amazon Inc., the largest book shop on internet has achieved a quarterly turnover of over USD 21 Billion for Q4 of year 2012. Compare the same to Barnes and Noble, one of the oldest book shops in US having a Q4 2012, turnover of around USD 2 Billion. The difference is of 10 times and is a reflection that automation is the key. Amazon allowed users to access books at a click of button, and with ease. The success of Amazon, was not only the availability of books on internet but also, its ability to streamline the delivery mechanism. There are lot of Indian companies which have used the same model and are achieving success, namely Flipkart and Snapdeal. In fact, these online retailers are now a serious threat to the business of shopping malls. |

### 5.3.3 How to go about BPA?

The steps to go about implementing business process automation are depicted here in Fig. 5.3.1. One important point to remember is that not all processes can be automated at a time. The best way to go about automation is to first understand the criticality of the business process to the enterprise. Let us discuss the key steps in detail.

**(i) Step 1: Define why we plan to implement a BPA?**

The primary purpose for which an enterprise implements automation may vary from enterprise to enterprise. A list of generic reasons for going for BPA may include any or combination of the following:

- Errors in manual processes leading to higher costs.
- Payment processes not streamlined, due to duplicate or late payments, missing early pay discounts, and losing revenue.
- Paying for goods and services not received.
- Poor debtor management leading to high invoice aging and poor cash flow.
- Not being able to find documents quickly during an audit or lawsuit or not being able to find all documents.
- Lengthy or incomplete new employee or new account on-boarding.
- Unable to recruit and train new employees, but where employees are urgently required.
- Lack of management understanding of business processes.
- Poor customer service.

| | |
|---|---|
| Step 1: Define why we plan to implement BPA? | • The answer to this question will provide justification for implementing BPA. |
| Step 2: Understand the rules/ regulation under which it needs to comply with? | • The underlying issue is that any BPA created needs to comply with applicable laws and regulations. |
| Step 3: Document the process, we wish to automate. | • The current processes which are planned to be automated need to be correctly and completely documented at this step. |
| Step 4: Define the objectives/goals to be achieved by implementing BPA. | • This enables the developer and user to understand the reasons for going for BPA. The goals need to be precise and clear. |
| Step 5: Engage the business process consultant. | • Once the entity has been able to define the above, the entity needs to appoint an expert, who can implement it for the entity. |
| Step 6: Calculate the RoI for project. | • The answer to this question can be used for convincing top management to say 'yes' to the BPA exercise. |
| Step 7: Development of BPA. | • Once the top management grant their approval, the right business solution has to be procured and implemented or developed and implemented covering the necessary BPA. |
| Step 8: Testing the BPA. | • Before making the process live, the BPA solutions should be fully tested. |

**Fig. 5.3.1: Steps involved in Implementing Business Process Automation**

### (ii) Step 2: Understand the rules / regulation under which enterprise needs to comply with?

One of the most important steps in automating any business process is to understand the rules of engagement, which include following the rules, adhering to regulations and following document retention requirements. This governance is established by a combination of internal corporate policies, external industry regulations and local, state, and central laws. Regardless of the source, it is important to be aware of their existence and how they affect the documents that drive the processes. It is important to understand that laws may require documents to be retained for specified number of years and in a specified format. Entity needs to ensure that any BPA adheres to the requirements of law.

### (iii) Step 3: Document the process, we wish to automate

At this step, all the documents that are currently being used need to be documented. The following aspects need to be kept in mind while documenting the present process:

- What documents need to be captured?
- Where do they come from?
- What format are they in: Paper, FAX, email, PDF etc.?
- Who is involved in processing of the documents?
- What is the impact of regulations on processing of these documents?
- Can there be a better way to do the same job?
- How are exceptions in the process handled?

The benefit of the above process for user and entity being:

- It provides clarity on the process.
- It helps to determine the sources of inefficiency, bottlenecks, and problems.
- It allows tore-design the process to focus on the desired result with workflow automation.

An easy way to do this is to sketch the processes on a piece of paper, possibly in a flowchart format. Visio or even Word can be used to create flowcharts easily.

It is important to understand that no automation shall benefit the entity, if the process being automated is error-prone. Investment in hardware, workflow software and professional services, would get wasted if the processes being automated are not made error-free. Use of technology needs to be made to realize the goal of accurate, complete and timely processing of data so as to provide right information to the right people safely and securely at optimum cost.

**(iv) Step 4: Define the objectives/goals to be achieved by implementing BPA**

Once the above steps have been completed, entity needs to determine the key objectives of the process improvement activities. When determining goals, remember that goals need to be **SMART**:

- Specific: Clearly defined,
- Measurable: Easily quantifiable in monetary terms,
- Attainable: Achievable through best efforts,
- Relevant: Entity must be in need of these, and
- Timely: Achieved within a given time frame.

For example,

**Case 1:** For vendor's offering early payment discounts, entity needs to consider:

- How much could be saved if they were taken advantage of, and if the entity has got the cash flow to do so?

- Vendor priority can be created based on above calculations, for who gets paid sooner rather than later.

**Case 2:** To determine the average invoice aging per customer. Entity can decide to reduce the average from 75 days to 60 days. This alone can dramatically improve cash flow.

**(v) Step 5: Engage the business process consultant**

This is again a critical step to achieve BPA. To decide as to which company/ consultant to partner with, depends upon the following:

- Objectivity of consultant in understanding/evaluating entity situation.
- Does the consultant have experience with entity business process?
- Is the consultant experienced in resolving critical business issues?
- Whether the consultant is capable of recommending and implementing a combination of hardware, software and services as appropriate to meeting enterprise BPA requirements?
- Does the consultant have the required expertise to clearly articulate the business value of every aspect of the proposed solution?

**(vi) Step 6: Calculate the RoI for project**

The right stakeholders need to be engaged and involved to ensure that the benefits of BPA are clearly communicated and implementation becomes successful. Hence, the required business process owners have to be convinced so as to justify the benefits of BPA and get approval from senior management. A lot of meticulous effort would be required to convince the senior management about need to implement the right solution for BPA. The right business case has to be made covering technical and financial feasibility so as to justify and get approval for implementing the BPA. The best way to convince would be to generate a proposition that communicates to the stakeholders that BPA shall lead to not only cost savings for the enterprise but also improves efficiency and effectiveness of service offerings.

Some of the methods for justification of a BPA proposal may include:

- Cost Savings, being clearly computed and demonstrated.
- How BPA could lead to reduction in required manpower leading to no new recruits need to be hired and how existing employees can be re-deployed or used for further expansion.
- Savings in employee salary by not having to replace those due to attrition.
- The cost of space regained from paper, file cabinets, reduced.
- Eliminating fines to be paid by entity due to delays being avoided.
- Reducing the cost of audits and lawsuits.
- Taking advantage of early payment discounts and eliminating duplicate payments.

- Ensuring complete documentation for all new accounts.
- New revenue generation opportunities.
- Collecting accounts receivable faster and improving cash flow.
- Building business by providing superior levels of customer service.
- Charging for instant access to records (e.g. public information, student transcripts, medical records)

The above can be very well presented to justify the proposal and convince management to go ahead with the project of BPA implementation as required for the enterprise.

**(vii) Step 7: Developing the BPA**

Once the requirements have been document, ROI has been computed and top management approval to go ahead has been received, the consultant develops the requisite BPA. The developed BPA needs to meet the objectives for which the same is being developed.

**(viii) Step 8: Testing the BPA**

Once developed, it is important to test the new process to determine how well it works and identify where additional "exception processing" steps need to be included. The process of testing is an iterative process, the objective being to remove all problems during this phase.

Testing allows room for improvements prior to the official launch of the new process, increases user adoption and decreases resistance to change. Documenting the final version of the process will help to capture all of this hard work, thinking and experience which can be used to train new people.

### 5.3.4 Case studies on Automation of Business Processes

**(i) Case 1: Automation of purchase order generation process, in a manufacturing entity**

Various steps of automation are given as follows:

**Step 1: Define why we plan to go for a BPA?**

The entity has been facing the problem of non-availability of critical raw material items which is leading to production stoppages and delay in delivery. Delay in delivery has already cost company in terms of losing customer and sales.

**Step 2: Understand the rules / regulation under which needs to comply with?**

The item is not covered by regulation, regarding quantity to be ordered or stored. To keep cost at minimum entity has calculated economic order quantity for which orders are placed.

**Step 3: Document the process, we wish to automate.**

The present process is manual where the orders are received by purchase department from stores department. Stores department generates the order based on manual stock register, based on item's re-order levels. The levels were decided five years back and stores records are not updated timely.

**Step 4: Define the objectives/goals to be achieved by implementing BPA**

The objective behind the present exercise is to ensure that there are no production losses due to non-availability of critical items of inventory. This shall automatically ensure timely delivery of goods to customer.

**Step 5: Engage the business process consultant**

ABC Limited, a consultant of repute, has been engaged for the same. The consultant has prior experience and knowledge about entity's business.

**Step 6: Calculate the ROI for project**

The opportunity loss for the project comes to around ₹ 100/- lakhs per year. The cost of implementing the whole BPA shall be around ₹ 50/- lakhs. It is expected that the opportunity loss after BPA shall reduce to ₹ 50 lakhs in year one, ₹ 25/- lakhs in later years for the next five years.

For students:

- Is the project worth going ahead?
- What is the RoI, based on three years data?
- What is the payback period?

**Step 7: Developing the BPA**

Once the top management says yes, the consultant develops the necessary BPA. The BPA is to generate purchase orders as soon as an item of inventory reaches its re-order level. To ensure accuracy, all data in the new system need to be checked and validated before being put the same into system:

- Item's inventory was physically counted before uploading to new system.
- Item's re-order levels were recalculated.
- All items issued for consumption were timely updated in system.
- All Purchase orders automatically generated are made available to Purchase manager at end of day for authorizations.

**Step 8: Testing the BPA**

Before making the process live, it should be thoroughly tested.

**(ii) Case 2: Automation of employee attendance**

Various steps of automation are given as follows:

**Step 1: Define why we plan to go for a BPA?**

The system of recording of attendance being followed is not generating confidence in employees about the accuracy. There have been complaints that salary payouts are not as per actual attendance. It has also created friction and differences between employees, as some feels that other employees have been paid more or their salary has not been deducted for being absent.

**Step 2: Understand the rules/regulation under which needs to comply with?**

A number of regulations are applicable to employee attendance including Factories Act 1948, Payment of Wages Act 1936, State laws, etc. This is a compliance requirement and hence, any BPA needs to cater to these requirements.

**Step 3: Document the process, we wish to automate.**

The present system includes an attendance register and a register at the security gate. Employees are expected to put their signatures in attendance registers. The register at the gate is maintained by security staff, to mark when an employee has entered. There is always a dispute regarding the time when an employee has entered and what has been marked in the security register. The company policy specifies that an employee coming late by 30 minutes for two days in a month shall have a ½ day salary deduction. There are over-writing in attendance register, leading to heated arguments between human resource department staff and employees. As the time taken to arrive at the correct attendance is large, there is a delay in preparation of salary. The same has already lead to penal action against company by labor department of the state.

**Step 4: Define the objectives/goals to be achieved implementing BPA**

The objective for implementing BPA, being:

- Correct recording of attendance.
- Timely compilation of monthly attendance so that salary can be calculated and distributed on a timely basis.
- To ensure compliance with statutes.

**Step 5: Engage the business process consultant**

XYZ Limited a consultant of repute has been engaged for the same. The consultant has prior experience and also knowledge about entity's business.

**Step 6: Calculate the RoI for project**

The BPA may provide Tangible benefits in the form of reduced penalties and intangible benefits which may include:

- Better employee motivation and morale,
- Reduced difference between employees,
- More focus on work rather than salary, and
- Improved productivity.

**Step 7: Developing the BPA**

Implementing BPA includes would result in the following:

- All employees would be given electronic identity cards.

- The cards would contain details about employees.
- The attendance system would work in the following manner:
  - Software with card reading machine would be installed at the entry gate.
  - Whenever an employee enters or leaves the company, he/she needs to put the card in front of machine.
  - The card reading machine would be linked to the software which would record the attendance of the employee.
  - At the end of month the software would print attendance reports employee-wise. These reports would also point out how many days an employee has reported late in the month.
  - Based on this report monthly attendance is put in the system to generate the monthly salary.

**Step 8: Testing the BPA**

Before making the process live, it should be thoroughly tested.

The above illustrations are of entities, which have gone for business process automation. There are thousands of processes across the world for which entity have gone for BPA and reaped numerous benefits. These include:

- Tracking movement of goods,
- Sales order processing,
- Customer services departments,
- Inventory management,
- Employee Management System, and
- Asset tracking systems.

### 5.3.5 Applications that help entity to achieve BPA

Many applications are available today that help enterprise to achieve business process automation. Few applications may be simpler; others may be more complex based on nature of process being considered. Some of them are mentioned below:

- **TALLY:** It is an accounting application that helps entity to automate processes relating to accounting of transactions. It also helps to achieve automation of few processes in inventory management. The latest version has been upgraded to help user achieve TAX compliances also. It has features such as Remote Access Capabilities, Tax Audit and Statutory Compliance, Payroll, Excise for Manufacturers, Multilingual Support, VAT Composition Returns, TDS, VAT (Value Added Tax), Rapid Implementation, Real Time Processing, Dynamic Interactive Reports and Unique Drill-Down Facility, Unlimited Companies and Periods of Accounting.

- **SAP R/3:** It is ERP software, which allows an entity to integrate its business processes. ERP stands for Enterprise Resource Planning, which aims at better utilization of the resources and helps entity achieve better business performance. It has the features such as time management, reporting and analytics, budget monitoring, workflow approval, sales management, team management, leave management, travel management, recruitment management and demand planning. This is used by most of the large enterprises across the world and covers enterprise automation end-to-end.
- **MS Office Applications:** These are various office automation systems made available by Microsoft Corporation which include MS Word, MS Excel, MS PowerPoint, MS Access, etc. Each of these software help to achieve automation of various tasks in the office. It has features such as customized ribbon, backstage view, built-in graphics toolset, enhanced security, excel spark lines, pivot for Excel, PowerPoint broadcast, Power Point compression, paste, preview and outlook conversation view.
- **Attendance Systems:** Many attendance automation systems are available in the market. The application helps entity to automate the process of attendance tracking and report generation. It has features such as supervisor login access, holiday pay settings, labour distribution, employee scheduling and rounding, employee view time card, overtime settings, battery-backed employee database and optional door/gate access control.
- **Vehicle Tracking System:** A lot of applications have been developed that allow entity to track their goods while in transit. Few applications are high end, allowing owner of goods to check the temperature of cold stored goods while in transit. It has features such as GPS based location, GPRS connection based real-time online data-logging and reporting, route accuracy on the fly while device is moving, real-time vehicle tracking, geo-fencing, SMS & e-mail notifications, over-the-air location query support, on-board memory to store location inputs during times when GPRS is not available or cellular coverage is absent.
- **Automated Toll Collection Systems:** As India progresses through creation of the golden quadrilateral project, many toll booths have been built to collect tolls. Many toll booths allow users to buy pre-paid cards, where user need not stop in lane to pay toll charges, but just swipe / wave the card in front of a scanner. The system keeps the track of card and the number of time same has been swiped / waved. It has features such as real-time toll plaza surveillance system, automatic vehicle identification system (based on in-road sensors), license plate recognition, zoom capability on captured images, laser based toll audit systems, automated vehicle classification, transaction processing and violation enforcement.
- **Department Stores Systems:** There has been huge development in the retail sector in India. The same has created a need to have systems to cater to the ever increasing need of Indian consumers. Two critical elements for managing departmental stores have been automated in India; they include the billing processes and inventory management. It has features such as point of sale, multi-channel operation, supplier database, products

database, purchase ordering, management reporting, multiple promotions, loyalty schemes, stock control and inventory management.

- **Travel Management Systems:** Many business processes specific to this industry have been automated, including ticket booking for air, bus, train, hotel, etc. It has features such as streamlined foreign travel approval process, configurable to match enterprise's foreign travel program, build-in and manage travel policy compliance, 'safe return' process for people tracking, traveler portal for up to date information, secure traveler profile information, online retrieval of e-tickets, reservations, visas & inoculation records, management of entry visas & medical requirements, front, mid and back office tools on a single, and web based platform.
- **Educational Institute Management Systems:** India probably produces maximum number of engineers, doctors, MBAs and CAs across the world. A lot of automation has been achieved, including student tracking and record keeping. ICAI, itself is a good example of this automation. A student based on his/her registration number can file many documents online including exam forms. It has features such as student's registration, student's admission, fee collection, student's attendance, result management, result analysis, library management, HR management, staff attendance, payroll system, time-table management, financial accounting, assets management and MIS.
- **File Management System:** With increasing inventory of office files and records, many office automation systems have been developed. These allow office records to be kept in soft copy and easy tracking of the same. It has features such as web access, search, Microsoft office integration, records management software, electronic forms (e-forms), calendar, document version control, document scanning and imaging, check documents out/ check documents in, document "tagging" or metadata capture, virtual folders and document linking.
- **Other Systems:** The banking systems, the railway reservations systems and stock exchange systems are good examples of business process automations achieved.

## 5.4 Information Processing

Data when processed to meet the needs of the users is called information. Computer can be used as an aid to process this data so as to provide information, which has meaning to the users. **Information** may be defined as processed data, which is of value to the user. Information is necessary for decision making and survival of an entity as success of business depends upon making right decisions at the right time on the basis of the right information available. The effort to create information from raw data is known as **Information Processing**.

Classification of information is based on level of human/computer intervention, which is given as follows:

### (i) Manual Information Processing Cycle

These are the systems where the level of manual intervention is very high. Say for example, valuation of exam papers, teaching, operations in operation theatres, ticket checking by railway staff in trains, buying of grocery, billing done by small medical shops, people maintaining books manually, etc.

Components of manual information processing cycle include:

- **Input:** Put details in register.
- **Process:** Summarize the information.
- **Output:** Present information to management in the form of reports.

A pictorial representation of the same is given in Fig. 5.4.1. As the level of human intervention is very high the quality of information generated from these systems is prone to flaws such as delayed information, inaccurate information, incomplete information and low levels of detail.


**Fig. 5.4.1: Manual Processing Cycle**

**(ii) Computerized Information Processing Cycle**

These are systems where computers are used at every stage of transaction processing. The components of a computerized information processing cycle include:

- **Input:** Entering data into the computer;
- **Processing:** Performing operations on the data;
- **Storage:** Saving data, programs, or output for future use; and
- **Output:** Presenting the results.

A pictorial representation of the same is given in Fig. 5.4.2. As the processing is computerized the quality of information generated from these systems is timely, accurate, fast and reliable.

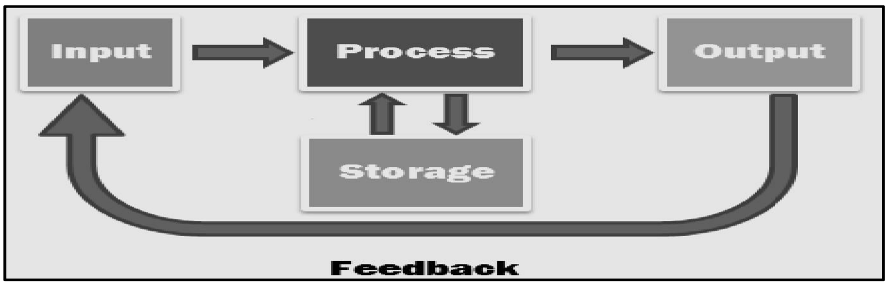


**Fig. 5.4.2: Computerized Processing Cycle**

The world has been rapidly moving towards more and more automation. Traditional manual systems are being replaced by computerised systems. This change has impacted businesses majorly. Consumer attitude towards business is directed by the level of computerisation businesses have adopted. There is preference to reach to those people who are fast, accurate and timely. The consumer behaviour has impacted the way businesses operate. The same is explained in the next section, which deals with delivery channels.

## 5.5 Delivery Channels

Delivery channels refer to the mode through which information or products are delivered to users. For example,

- Delivery channels for **information** include:
    - Intranet: Network within the company/enterprise;
    - E-mail: The most widely used delivery channel for information today;
    - Internal newsletters and magazines;
    - Staff briefings, meetings and other face-to-face communications methods;
    - Notice boards in communal areas;
    - Manuals, guides and other printed resources;
    - Hand-held devices (PDAs, etc.); and
    - Social networking sites, like Facebook, WhatsApp, etc.
- Delivery channels for **products** include:
    - Traditional models, brick and mortar type;
    - Buying from a shop;
    - Home delivery of products;
    - Buying from a departmental store; and
    - Buying online, getting home delivery and making cash payment on delivery.

### 5.5.1 Importance

Enterprises need to be aware of 'what information is required for effective delivery of products or services'. It is important to have proper and accurate delivery channels for information or product distribution and to consider each of these channels while planning an overall information management and communications strategy. In practice, more than one of these delivery channels will be needed, with different channels used to reach specific user groups.

### 5.5.2 Information Delivery Channel: How to choose one?

When choosing appropriate delivery channels, consider the following suggestions:

- **More than just the Intranet:** It is rarely sensible to have a goal of "increasing intranet usage". Fundamentally, staff will (and should) use whichever methods are easiest and most efficient to obtain information. Any attempt to move staff usage to the intranet away from existing information sources will almost certainly fail, unless the intranet is easier than the current methods.

For example, it may be effective to put a notice on the notice board in a canteen (such as for field staff), rather than putting the same on intranet.

- **Understand staff needs & environment:** Job roles and work environments will have a major impact upon the suitability of delivery channels. This includes which systems do staff use, their level of PC access, their amount of computer knowledge, and their geographic location.

  For example, there may only be a single PC in an enterprise and people working may have no time available in the day to access the intranet anyway. In this situation, the intranet would not be an effective delivery channel and face-to-face communication may be better.

- **Traditional Channel need to be formalized:** Instead of attempting to eliminate existing information sources in favor of the intranet, it may be more beneficial to formalize the current practices.

  For example, staff may have key details pinned to the walls of their cubicles or work locations. The best outcome in this situation could be to organize monthly reprinting of these notes to ensure they are up-to-date.

### 5.5.3 Product Delivery Channels: How to choose one?

The way customer response is changing the way business operates. Online retailers are giving a run for money to physical mall owners. Customers while going for online shopping find wide range of products. The best part is that, a customer in a small town/village can have a shopping experience of a large store.

The change is so drastic that physical brick and mortar sellers have to bring themselves on internet. The change is other way round also. Many online travel sites have opened brick and mortar office in cities and towns, to meet their customers. The key words are “convincing” and “capturing” the customer. So, any delivery channel shall work till it convinces customer.

The customers have moved from purchase of physical books to e-books. This shift has forced business to strategize their delivery channels.

## 5.6 Controls in BPA

In today’s computerized information systems, most of the business processes are being automated. Enterprises are increasingly relying on IT for business information and transaction processing. The growth of e-commerce has been supported by the growth of the Internet. The same has completely changed the business processes. The innovations in IT components such as hardware, software, networking technology, communication technology and ever-increasing bandwidth are leading to evolution of completely new business models.

All these new business models and new methods presume that the information required by business managers is available all the time and is accurate. However, there is a need to ensure that all information that is generated from system is accurate, complete and reliable for decision making, hence the requirement for proper controls.

**Control** is defined as policies, procedures, practices and organization structure that are designed to provide reasonable assurance that business objectives are achieved and undesired events are prevented or detected and corrected.

### 5.6.1 Control Objectives

Major control objectives are given as follows:

- **Authorization** - ensures that all transactions are approved by responsible personnel in accordance with their specific or general authority before the transaction is recorded.
- **Completeness** - ensures that no valid transactions have been omitted from the accounting records.
- **Accuracy** - ensures that all valid transactions are accurate, consistent with the originating transaction data, and information is recorded in a timely manner.
- **Validity** - ensures that all recorded transactions fairly represent the economic events that actually occurred, are lawful in nature, and have been executed in accordance with management's general authorization.
- **Physical Safeguards and Security** - ensures that access to physical assets and information systems are controlled and properly restricted to authorized personnel.
- **Error Handling** - ensures that errors detected at any stage of processing receive prompt corrective action and are reported to the appropriate level of management.
- **Segregation of Duties** - ensures that duties are assigned to individuals in a manner that ensures that no one individual can control both the recording function and the procedures relative to processing a transaction.

The controls are used to **Prevent**, **Detect**, or **Correct** unlawful events. An unlawful event can arise if unauthorized, inaccurate, incomplete, redundant, ineffective, or inefficient input enters the system.

- **Preventive Control:** Those, which prevent occurrence of an error/fraud, say security guards
- **Detective Control:** Those, which capture an error, say audit trail.
- **Corrective Control:** Those, which correct an error or reduce the loss due to error/risk, say insurance policy.

### 5.6.2 Information Systems' Controls

Usually auditors cannot examine and evaluate all the data processing carried out within an organization. They need guidelines that will direct them toward those aspects of the information systems function in which material losses or account misstatements are most likely to occur. Ultimately auditors must evaluate the reliability of controls; they need to understand the nature of controls. Controls reduce expected losses from unlawful events by -

(i) decreasing the probability of the event occurring in the first place, or

(ii) limiting the losses that arise of the event occurs.

There can be different aspects under which the study on the controls be discussed. However, to understand the controls relevant for information systems and their audit, we shall divide the study in two parts – Managerial controls and Application Controls.

**A. Managerial Controls:** In this part, we shall examine controls over the managerial functions that must be performed to ensure the development, implementation, operation and maintenance of information systems in a planned and controlled manner in an organization. The controls at this level provide a stable infrastructure in which information systems can be built, operated, and maintained on a day-to-day basis as discussed in Table 5.6.1.

**Table 5.6.1: Types of Management Subsystem and their description***

| Management Subsystem | Description of Subsystem |
|---|---|
| **Top Management** | Top management must ensure that information systems function is well managed. It is responsible primarily for long – run policy decisions on how Information Systems will be used in the organization. |
| **Information Systems Management** | IS management has overall responsibility for the planning and control of all information system activities. It also provides advice to top management in relation to long-run policy decision making and translates long-run policies into short-run goals and objectives. |
| **Systems Development Management** | Systems Development Management is responsible for the design, implementation, and maintenance of application systems. |
| **Programming Management** | It is responsible for programming new system; maintain old systems and providing general systems support software. |
| **Data Administration** | Data administration is responsible for addressing planning and control issues in relation to use of an organization's data. |
| **Quality Assurance Management** | It is responsible for ensuring information systems development; implementation, operation, and maintenance conform to established quality standards. |

* "Information Systems Control and Audit", Ron Weber, Third Impression 2009, Pearson Education, Page No. 63

| | |
|---|---|
| **Security Administration** | It is responsible for access controls and physical security over the information systems function. |
| **Operations Management** | It is responsible for planning and control of the day-to-day operations of information systems. |

**B. Application Controls:** In the second part, we shall examine the application functions that need to be in place to accomplish reliable information processing. Refer to the Table 5.6.2.

**Table 5.6.2: Types of Application Subsystem and their description***

| **Application Subsystem** | **Description of Subsystem** |
|---|---|
| **Boundary** | Comprises the components that establish the interface between the user and the system. |
| **Input** | Comprises the components that capture, prepare, and enter commands and data into the system. |
| **Communication** | Comprises the components that transmit data among subsystems and systems. |
| **Processing** | Comprises the components that perform decision making, computation, classification, ordering, and summarization of data in the system. |
| **Output** | Comprises the components that retrieve and present data to users of the system. |
| **Database** | Comprises the components that define, add, access, modify, and delete data in the system. |

### 5.6.3 Managerial Functions Based Controls

(i) **Top Management and Information Systems Management Controls:** The senior managers who take responsibility for IS function in an organization face many challenges. The major functions that a senior manager must perform are as follows:

- **Planning** – determining the goals of the information systems function and the means of achieving these goals;
- **Organizing** – gathering, allocating, and coordinating the resources needed to accomplish the goals;

* "Information Systems Control and Audit", Ron Weber, Third Impression 2009, Pearson Education, Page No. 63 and 64

- **Leading** – motivating, guiding, and communicating with personnel; and
- **Controlling** – comparing actual performance with planned performance as a basis for taking any corrective actions that are needed.

Top management must prepare two types of information systems plans for the information systems function: a **Strategic Plan** and an **Operational Plan**. The **Strategic Plan** is the long-run plan covering, say, the next three to five years of operations whereas the **Operational Plan** is the short-plan covering, say, next one to three years of operations. Both the plans need to be reviewed regularly and updated as the need arises. The planning depends upon factors such as the importance of existing systems, the importance of proposed information systems, and the extent to which IT has been integrated into daily operations

**(ii) Systems Development Management Controls:** Systems Development Management has responsibility for the functions concerned with analyzing, designing, building, implementing, and maintaining information systems. Three different types of audits may be conducted during system development process as discussed in the Table 5.6.3:

**Table 5.6.3: Different types of Audit during System Development Process**

| | |
|---|---|
| **Concurrent Audit** | Auditors are members of the system development team. They assist the team in improving the quality of systems development for the specific system they are building and implementing. |
| **Post-implementation Audit** | Auditors seek to help an organization learn from its experiences in the development of a specific application system. In addition, they might be evaluating whether the system needs to be scrapped, continued, or modified in some way. |
| **General Audit** | Auditors evaluate systems development controls overall. They seek to determine whether they can reduce the extent of substantive testing needed to form an audit opinion about management's assertions relating to the financial statements for systems effectiveness and efficiency. |

**(iii) Programming Management Controls:** Program development and implementation is a major phase within the systems development life cycle. The primary objectives of this phase are to produce or acquire and to implement high-quality programs. The program development life cycle comprises six major phases – **Planning**; **Design**; **Control**; **Coding**; **Testing**; and **Operation and Maintenance** with Control phase running in parallel for all other phases as shown in the Table 5.6.4. The purpose of the control phase during software development or acquisition is to monitor progress against plan and to ensure software released for production use is authentic, accurate, and complete.

**Table 5.6.4: Phases of Program Development Life Cycle**

| Phase | Controls |
|---|---|
| **Planning** | Techniques like Work Breakdown Structures (WBS), Gantt Charts and PERT (Program Evaluation and Review Technique) Charts can be used to monitor progress against plan. |
| **Design** | A systematic approach to program design, such as any of the structured design approaches or object-oriented design is adopted. |
| **Coding** | Programmers must choose a module implementation and integration strategy (like Top-down, bottom-up and Threads approach), a coding strategy (that follows the percepts of structured programming), and a documentation strategy (to ensure program code is easily readable and understandable). |
| **Testing** | Three types of testing can be undertaken:<br>• Unit Testing – which focuses on individual program modules;<br>• Integration Testing – Which focuses in groups of program modules; and<br>• Whole-of-Program Testing – which focuses on whole program.<br>These tests are to ensure that a developed or acquired program achieves its specified requirements. |
| **Operation and Maintenance** | Management establishes formal mechanisms to monitor the status of operational programs so maintenance needs can be identified on a timely basis. Three types of maintenance can be used –<br>Repair maintenance – in which program errors are corrected;<br>Adaptive Maintenance – in which the program is modified to meet changing user requirements; and<br>Perfective Maintenance - in which the program is tuned to decrease the resource consumption. |

**(iv) Data Resource Management Controls:** Many organizations now recognize that data is a critical resource that must be managed properly and therefore, accordingly, centralized planning and control are implemented. For data to be managed better users must be able to share data, data must be available to users when it is needed, in the location where it is needed, and in the form in which it is needed. Further it must be possible to modify data fairly easily and the integrity of the data be preserved. If data repository system is used properly, it can enhance data and application system reliability. It must be controlled carefully, however, because the consequences are serious if the data definition is compromised or destroyed. Careful control should be exercised over the roles by appointing senior, trustworthy persons, separating duties to the extent possible and maintaining and monitoring logs of the data administrator's and database administrator's activities.

**(v) Quality Assurance Management Controls:** Organizations are increasingly producing safety-critical systems and users are becoming more demanding in terms of the quality of the software they employ to undertake their work. Organizations are undertaking more ambitious information systems projects that require more stringent quality requirements and are becoming more concerned about their liabilities if they produce and sell defective software.

**(vi) Security Management Controls:** Information security administrators are responsible for ensuring that information systems assets are secure. Assets are secure when the expected losses that will occur over some time are at an acceptable level. Some of the major threats and to the security of information systems and their controls are as discussed in the Table 5.6.5:

**Table 5.6.5: Major threats and their control measures**

| Threat | Control |
|---|---|
| **Fire** | Well-designed, reliable fire-protection systems must be implemented. |
| **Water** | Facilities must be designed and sited to mitigate losses from water damage |
| **Energy Variations** | Voltage regulators, circuit breakers, and uninterruptible power supplies can be used. |
| **Structural Damage** | Facilities must be designed to withstand structural damage. |
| **Pollution** | Regular cleaning of facilities and equipment should occur. |
| **Unauthorized Intrusion** | Physical access controls can be used. |
| **Viruses and Worms** | Controls to prevent use of virus-infected programs and to close security loopholes that allow worms to propagate. |
| **Misuse of software, data and services** | Code of conduct to govern the actions of information systems employees. |
| **Hackers** | Strong, logical access controls to mitigate losses from the activities of hackers. |

**(vii) Operations Management Controls:** Operations management is responsible for the daily running of hardware and software facilities. Operations management typically performs controls over the functions like Computer Operations, Communications Network Control, Data Preparation and Entry, Production control, File Library; Documentation and Program Library; Help Desk/Technical support; Capacity Planning and Performance Monitoring and Outsourced Operations. Operations management control must continuously monitor the performance of the hardware/software platform to ensure that systems are executing efficiently, an acceptable response time or turnaround time is being achieved, and an acceptable level of uptime is occurring.

### 5.6.4 Application Functions Based Controls (Refer to the Fig. 5.6.1)

**(i) Boundary Controls:** Controls in the boundary subsystem have three purposes -

- to establish the identity and authenticity of would-be-users of a computer system;
- to establish the identity and authenticity of computer-system resources that users wish to employ; and
- to restrict the actions undertaken by users who obtain computer resources to a set of authorized actions.

Some major types of controls exercised in the boundary subsystem are as follows:

- **Cryptographic Controls:** These are designed to protect the privacy of data and to prevent unauthorized modifications of data. Cryptography achieves this goal by scrambling data into codes (cryptograms) so that it is meaningless to anyone who does not possess the authentication to access the respective system resource or file.
- ***Access Controls*: *These controls restrict use of computer system resources to authorized users, limit the actions authorized users can taker with these resources, and ensure that users obtain only authentic computer system resources. In a shared resource environment, auditors should have two concerns – first, they need to determine how well any access control mechanism uses safeguards assets and preserves data integrity and secondly, given the capabilities of the access control mechanism that are available for any particular application system; auditors must determine whether the access controls chosen for that system suffice. An access control mechanism processes users' requests for resources in three steps:***
  - ***Identification*: *First users identify themselves to the mechanism, thereby indicating their intent to request system resources.***
  - ***Authentication*: *It is a two way process wherein users must authenticate themselves, and the mechanism in turn must authenticate itself. That means, not only must the mechanism be sure it has a valid user, users must also be sure that they have a valid mechanism.***
  - ***Authorization*: *Users must request specific resources and specify the actions they intend to take with the resources.***

  ***User identification by an authentication mechanism with personal characteristics like name, birth date, employee code, function, designation or a combination of two or more of these can be used as a password boundary access control.***
- **Personal Identification Numbers (PIN):** The Personal Identification Number is similar to a password assigned to a user by an institution based on the user characteristics and encrypted using a cryptographic algorithm. The application

generates a random number stored in its database independent of user identification details or a customer selected number.

- ***Digital Signatures*: *In computer system, Digital Signatures establish the authenticity of persons and prevent the denial of messages or contracts when data is exchanged electronically.***
- **Plastic Cards:** Plastic Cards are used to store information required in an authentication process. These cards that are used to identify a user need to go through procedural controls like application for a card, preparation of the card, issue of the card, use of the card and return of the card or card termination phases.

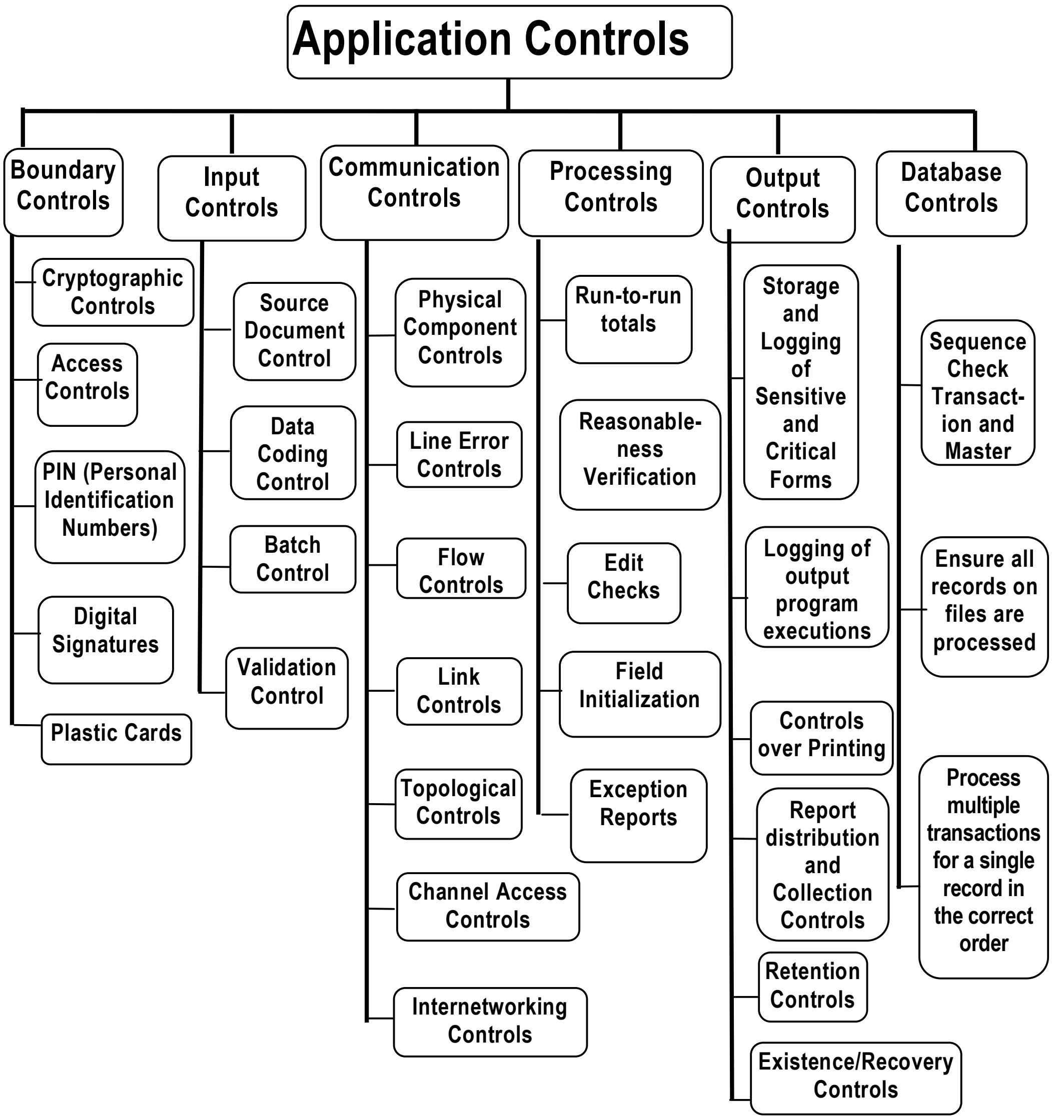


**Fig. 5.6.1: Types of Application Controls**

**(ii) Input Controls:** These are responsible for ensuring the accuracy and completeness of data that are input into an application system. Input controls are important since substantial time is spent on inputting data which involves human intervention and are therefore prone to errors and fraud. The type of data input method used in an information system affects asset safeguarding, data integrity, system effectiveness, and system efficiency objectives. If data is keyed into an information system via a terminal, high-quality screen design is important to minimizing input errors and to achieving effective and efficient input of data.

- **Source Document Control:** From a control viewpoint, a well-designed source document reduces the likelihood of data recording errors, increases the speed with which data can be recorded and controls the work flow. Source Document Controls facilitates the data entry into a computer system and subsequent reference checking.
- **Data Coding Controls:** Data Coding Controls are put in place to reduce user error during data feeding.
- **Batch Controls:** These are put in place at locations where batch processing is being used. Batch processing is where there is a time gap between occurrence and recording of transactions, that is, transactions are not recorded at the time of occurrence but are accumulated and a set (based on number/ time) is processed.
- **Validation Controls:** These validate the accuracy/correctness of input data. Input Validation Controls are intended to detect errors in transaction data before the data are processed.

***(iii) <u>Communication Controls</u>: Components in the communication subsystem are responsible for transporting data among all the other subsystems within a system and for transporting data to or receiving data from another system. Three types of exposure arise in the communication subsystem.***

***(a) As data is transported across a communication subsystem, it can be impaired through attenuation, delay distortion, and noise.***

***(b) The hardware and software components in a communication subsystem can fail.***

***(c) The communication subsystem can be subjected to passive or active subversive attacks.***

- ***<u>Physical Component Controls</u>: One way to reduce expected losses in the communication subsystem is to choose physical component that have characteristics that make them reliable and that incorporate features or provide controls that mitigate the possible effects of exposures. These controls involve Transmission Media - Bounded (Guided) Media or Unbounded***

***(Unguided) Media; Communication Lines – Private (Leased) or Public; Modems; Port Protection Devices; Multiplexors and Concentrators.***

- ***Line Error Controls: Whenever data is transmitted over a communication line, it can be received in error because of attenuation, distortion, or noise that occurs on the line. Error Detection (using Parity Checking, Cyclic Redundancy Checks (CRC) and Loop Check) and Error Correction (using forward Error Correcting Codes and Backward Error Correction) are the two major approaches under Line Error Controls.***
- ***Flow Controls: These are needed because two nodes in a network can differ in terms of the rate at which they can send receive and process data. The simplest form of flow control is "Stop-and-Wait Flow Control" in which the sender transmits a frame of data only when the receiver is ready to accept the frame.***
- ***Link Controls: This involves two common protocols – HDLC (Higher Level Data Control) and SDLC (Synchronous Data Link Control); the study of these is beyond the scope of this book.***
- ***Topological Controls: A communication network topology specifies the location of nodes within a network, the ways in which these nodes will be linked, and the data transmission capabilities of the links between the nodes. Some of the four basic topologies include Bus, Ring, Star and Tree Topology.***
- ***Channel Access Controls: Two different nodes in a network can compete to use a communication channel. Whenever the possibility of contention for the channel exists, some type of channel access control technique must be used. These techniques fall into two classes – Polling methods and Contention methods. Polling techniques establish an order in which a node can gain access to channel capacity; whereas in Contention methods, nodes in a network must compete with each other to gain access to a channel.***
- ***Internetworking Controls: Internetworking is the process of connecting two or more communication networks together to allow the users of one network to communicate with the users of other networks. Three types of devices are used to connect sub-networks in an Internet: Bridge, Router and Gateway.***

**(iv) Processing Controls:** Data processing controls perform validation checks to identify errors during processing of data. They are required to ensure both the completeness and accuracy of the data being processed. However, adequate controls should be enforced through the front end application system also, to have consistency in the control process. Some of them are as follows:

- **Run-to-Run Totals:** These help in verifying data that is subject to process through different stages. A specific record (probably the last record) can be used to maintain the control total.

- **Reasonableness Verification:** Two or more fields can be compared and cross verified to ensure their correctness.
- **Edit Checks:** Edit checks similar to the data validation controls can also be used at the processing stage to verify accuracy and completeness of data.
- **Field Initialization:** Data overflow can occur, if records are constantly added to a table or if fields are added to a record without initializing it, i.e., setting all values to zero before inserting the field or record.
- **Exception Reports:** Exception reports are generated to identify errors in data processed.
- **Existence/Recovery Controls:** The check-point/restart logs, facility is a short-term backup and recovery control that enables a system to be recovered if failure is temporary and localized.

**(v) Output Controls:** Output controls ensure that the data delivered to users will be presented, formatted and delivered in a consistent and secured manner. Whatever the type of output, it should be ensured that the confidentiality and integrity of the output is maintained and that the output is consistent. Output controls have to be enforced both in a batch-processing environment as well as in an online environment.

- **Storage and Logging of Sensitive and Critical Forms:** Pre-printed stationery should be stored securely to prevent unauthorized destruction or removal and usage. Only authorized persons should be allowed access to stationery supplies such as security forms, negotiable instruments etc.
- **Logging of Output Program Executions:** When programs, used for output of data, are executed, they should be logged and monitored.
- **Controls over Printing:** It should be ensured that unauthorized disclosure of information printed is prevented.
- **Report Distribution and Collection Controls:** Distribution of reports should be made in a secure way to avoid unauthorized disclosure of data. A log should be maintained as to what reports were generated and to whom it was distributed.
- **Retention Controls:** Retention controls consider the duration for which outputs should be retained before being destroyed. Consideration should be given to the type of medium on which the output is stored.
- **Existence/Recovery Controls:** These controls are needed to recover output in the event that it is lost or destroyed. If the output is written to a spool of files or report files and has been kept, then recovery is easy and straight-forward.

**(vi) Database Controls:** The database subsystem is responsible for defining, creating, modifying, deleting, and reading data in an information system. It maintains declarative data, relating to the static aspects of real-world objects and their associations, and procedural data, relating to the dynamic aspects of real-world objects and their associations. Database Controls protect the integrity of a database when application software acts as an interface to interact between the user and the database.

- **Sequence Check Transaction and Master Files:** Synchronization and the correct sequence of processing between the master file and transaction file is critical to maintain the integrity of updation, insertion or deletion of records in the master file with respect to the transaction records. If errors in this stage are overlooked, it leads to corruption of the critical data.
- **Ensure all records on files are processed:** While processing the transaction file records mapped to the respective master file the end-of-file of the transaction file with respect to the end-of-file of the master file is to be ensured.
- **Process multiple transactions for a single record in the correct order:** Multiple transactions can occur based on a single master record. For example, dispatch of a product to different distribution centers. The order in which transactions are processed against the product master record must be done based on a sorted transaction codes.

## 5.7 Emerging Technologies

Various emerging technologies/concepts are given in the following sections:

### 5.7.1 Virtualization

***In computing, virtualization means to create a virtual version of a device or resource, such as a server, storage device, network or even an operating system where the framework divides the resource into one or more execution environments. Virtualization refers to technologies designed to provide a layer of abstraction between computer hardware systems and the software running on them. By providing a logical view of computing resources, rather than a physical view; virtualization allows its' users to manipulate their systems' operating systems into thinking that a group of servers is a single pool of computing resources and conversely, allows its users to run multiple operating systems simultaneously on a single machine.***

***The core concept of Virtualization lies in Partitioning, which divides a single physical server into multiple logical servers. Once the physical server is divided, each logical server can run an operating system and applications independently.***

***For example - Partitioning of a hard drive is considered virtualization because one drive is partitioned in a way to create two separate hard drives. Devices, applications and human users are able to interact with the virtual resource as if it were a real single logical resource.***

Major applications of the concepts of the virtualization are given as follows:

- **Server Consolidation:** Virtual machines are used to consolidate many physical servers into fewer servers, which in turn host virtual machines. Each physical server is reflected as a virtual machine "guest" residing on a virtual machine host system. This is also known as "Physical-to-Virtual" or 'P2V' transformation.
- **Disaster Recovery:** Virtual machines can be used as "hot standby" environments for physical production servers. This changes the classical "backup-and-restore" philosophy, by providing backup images that can "boot" into live virtual machines, capable of taking over workload for a production server experiencing an outage.
- **Testing and Training**: Virtualization can give root access to a virtual machine. This can be very useful such as in kernel development and operating system courses.
- **Portable Applications:** Portable applications are needed when running an application from a removable drive, without installing it on the system's main disk drive. Virtualization can be used to encapsulate the application with a redirection layer that stores temporary files, windows registry entries and other state information in the application's installation directory and not within the system's permanent file system.
- **Portable Workspaces:** Recent technologies have used virtualization to create portable workspaces on devices like iPods and USB memory sticks.

***Some common types of Virtualization***

***Hardware Virtualization**: Hardware Virtualization or Platform Virtualization refers to the creation of a virtual machine that acts like a real computer with an operating system. Software executed on these virtual machines is separated from the underlying hardware resources. For example, a computer that is running Microsoft Windows may host a virtual machine that looks like a computer with the Linux operating system; based software that can be run on the virtual machine.*

***The basic idea of Hardware virtualization is to consolidate many small physical servers into one large physical server so that the processor can be used more effectively. The software that creates a virtual machine on the host hardware is called a hypervisor or Virtual Machine Manager. The hypervisor controls the processor, memory and other components by allowing several different operating systems to run on the same machine without the need for a source code. The operating system running on the machine will appear to have its own processor, memory and other components.***

***Network Virtualization**: Network virtualization is a method of combining the available resources in a network by splitting up the available bandwidth into channels, each of which is independent from the others, and each of which can be assigned (or reassigned) to a particular server or device in real time. This allows a large physical network to be provisioned into multiple smaller logical networks and conversely allows multiple physical LANs to be combined into a larger logical network. This behaviour* *allows administrators to improve network traffic control, enterprise and security. Network virtualization involves platform virtualization, often combined with resource virtualization.*

*Various equipment and software vendors offer network virtualization by combining any of the Network hardware such as switches and network interface cards (NICs); Network elements such as firewalls and load balancers; Networks such as virtual LANs (VLANs); Network storage devices; Network machine-to-machine elements such as telecommunications devices; Network mobile elements such as laptop computers, tablet computers, smart phones and Network media such as Ethernet and Fibre Channel. Network virtualization is intended to optimize network speed, reliability, flexibility, scalability, and security.*

***Storage Virtualization**: Storage virtualization is the apparent pooling of data from multiple storage devices, even different types of storage devices, into what appears to be a single device that is managed from a central console. Storage virtualization helps the storage administrator perform the tasks of backup, archiving, and recovery more easily -- and in less time -- by disguising the actual complexity of a Storage Area Network (SAN). Administrators can implement virtualization with software applications or by using hardware and software hybrid appliances. The servers connected to the storage system aren't aware of where the data really is. Storage virtualization is sometimes described as "abstracting the logical storage from the physical storage.*

### *5.7.2 Grid Computing*

*Grid Computing is a computer network in which each computer's resources are shared with every other computer in the system. It is a distributed architecture of large numbers of computers connected to solve a complex problem. In the grid computing model, servers or personal computers run independent tasks and are loosely linked by the Internet or low-speed networks.*

*A typical Grid Model is shown in Fig. 5.7.1.*

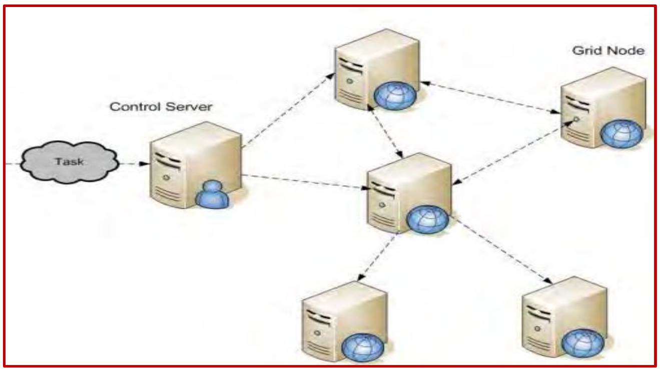


**Fig. 5.7.1: A Grid Model**

*It is a special kind of distributed computing. In distributed computing, different computers within the same network share one or more resources. In the ideal grid computing system, every resource is shared, turning a computer network into a powerful supercomputer. With the right user interface, accessing a grid computing system would look no different than accessing a local machine's resources. Every authorized computer would have access to enormous processing power and storage capacity.*

*(i) Benefits of Grid Computing*

- *Making use of Underutilized Resources: In most organizations, there are large amounts of underutilized computing resources. In some organizations, even the server machines can often be relatively idle. Grid computing provides a framework for exploiting these underutilized resources and thus has the possibility of substantially increasing the efficiency of resource usage. Grid computing (more specifically, a data grid) can be used to aggregate this unused storage into a much larger virtual data store, possibly configured to achieve improved performance and reliability over that of any single machine.*
- *Resource Balancing: For applications that are grid-enabled, the grid can offer a resource balancing effect by scheduling grid jobs on machines with low utilization. This feature of grid computing handles occasional peak loads of activity in parts of a larger organization. An unexpected peak can be routed to relatively idle machines in the grid; and if the grid is already fully utilized, the lowest priority work being performed on the grid can be temporarily suspended or even cancelled and performed again later to make room for the higher priority work.*
- *Parallel CPU Capacity: The potential for usage of massive parallel CPU capacity is one of the most common visions and attractive features of a grid. A CPU-intensive grid application can be thought of as many smaller sub-jobs, each executing on a different machine in the grid. To the extent that these sub-jobs do not need to communicate with each other, the more scalable the application becomes. A perfectly scalable application will, for example, finish in one tenth of the time if it uses ten times the number of processors*
- *Virtual resources and virtual organizations for collaboration: Another capability enabled by grid computing is to provide an environment for collaboration among a wider audience. The users of the grid can be organized dynamically into a number of virtual organizations, each with different policy requirements. These virtual organizations can share their resources such as data, specialized devices, software, services, licenses, and so on, collectively as a larger grid. These resources are virtualized to give them a more uniform interoperability among heterogeneous grid participants. The participants and users of the grid can be members of several real and virtual organizations.*

*The grid can help in enforcing security rules among them and implement policies, which can resolve priorities for both resources and users.*

- *Access to additional resources: In addition to CPU and storage resources, a grid can provide access to other resources as well. For example, if a user needs to increase their total bandwidth to the Internet to implement a data mining search engine, the work can be split among grid machines that have independent connections to the Internet. In this way, total searching capability is multiplied, since each machine has a separate connection to the Internet. Some machines may have expensive licensed software installed that users require. Users' jobs can be sent to such machines, more fully exploiting the software licenses. Some machines on the grid may have special devices. All of these will make the grid look like a large system with a collection of resources beyond what would be available on just one conventional machine.*
- *Reliability: High-end conventional computing systems use expensive hardware to increase reliability. The machines also use duplicate processors in such a way that when they fail, one can be replaced without turning the other off. Power supplies and cooling systems are duplicated. The systems are operated on special power sources that can start generators if utility power is interrupted. All of this builds a reliable system, but at a great cost, due to the duplication of expensive components.*
- *Management: The goal to virtualize the resources on the grid and more uniformly handle heterogeneous systems create new opportunities to better manage a larger, more distributed IT infrastructure. The grid offers management of priorities among different projects. Aggregating utilization data over a larger set of projects can enhance an organization's ability to project future upgrade needs. When maintenance is required, grid work can be rerouted to other machines without crippling the projects involved.*

*(ii) Types of Resources*

*A grid is a collection of machines, sometimes referred to as nodes, resources, members, donors, clients, hosts and many other such terms. They all contribute any combination of resources to the grid as a whole. Some resources may be used by all users of the grid, while others may have specific restrictions.*

- *Computation: The most common resource is Computing Cycles provided by the processors of the machines on the grid where processors can vary in speed, architecture, software platform, and other associated factors such as memory, storage, and connectivity. There are three primary ways to exploit the computation resources of a grid.*
  - *To run an existing application on an available machine on the grid rather than locally;*

- *To use an application designed to split its work in such a way that the separate parts can execute in parallel on different processors; and*
- *To run an application, that needs to be executed many times, on many different machines in the grid.*

- *Storage: The second most common resource used in a grid is Data Storage. A grid providing an integrated view of data storage is sometimes called a Data Grid. Each machine on the grid usually provides some quantity of storage for grid use, even if temporary. Storage can be memory attached to the processor or it can be secondary storage, using hard disk drives or other permanent storage media. More advanced file systems on a grid can automatically duplicate sets of data, to provide redundancy for increased reliability and increased performance.*
- *Communications: Communications within the grid are important for sending jobs and their required data to points within the grid. The bandwidth available for such communications can often be a critical resource that can limit utilization of the grid. Redundant communication paths are sometimes needed to better handle potential network failures and excessive data traffic. In some cases, higher speed networks must be provided to meet the demands of jobs transferring larger amounts of data.*
- *Software and Licenses: The grid may have software installed that may be too expensive to install on every grid machine. Some software licensing arrangements permit the software to be installed on all of the machines of a grid but may limit the number of installations that can be simultaneously used at any given instant. License management software keeps track of how many concurrent copies of the software are being used and prevents more than that number from executing at any given time.*
- *Special equipment, capacities, architectures, and policies: Platforms on the grid will often have different architectures, operating systems, devices, capacities, and equipment. Each of these items represents a different kind of resource that the grid can use as criteria for assigning jobs to machines. For example, some machines may be designated to only be used for medical research. These would be identified as having a medical research attribute and the scheduler could be configured to only assign jobs that require machines of the medical research resource.*

*(iii) Using a Grid: User's Perspective*

- *Enrolling and installing Grid Software: A user may first have to enroll his machine as a donor on the grid and install the provided grid software on his own machine that may require authentication for security purposes. The user positively establishes his identity with a Certificate Authority who must take* *steps to assure that the user is in fact who he claims to be. Once the user and/or machine are authenticated, the grid software is provided to the user for installing on his machine for the purposes of using the grid as well as donating to the grid.*

- *Logging onto the grid: Most grid systems require the user to log on to a system using an ID that is enrolled in the grid. Once logged on, the user can query the grid and submit jobs. Some grid implementations permit some query functions if the user is not logged into the grid or even if the user is not enrolled in the grid.*
- *Queries and submitting jobs: The user will usually perform some queries to check to see how busy the grid is, to see how his submitted jobs are progressing, and to look for resources on the grid. Grid systems usually provide command-line tools as well as graphical user interfaces (GUIs) for queries. Job submission usually consists of three parts, even if there is only one command required.*
  - *First, some input data and possibly the executable program or execution script file are sent to the machine to execute the job.*
  - *Second, the job is executed on the grid machine. The grid software running on the donating machine executes the program in a process on the user's behalf.*
  - *Third, the results of the job are sent back to the submitter.*
- *Data configuration: The data accessed by the grid jobs may simply be staged in and out by the grid system. However, depending on its size and the number of jobs, this can potentially add up to a large amount of data traffic. For example, if there will be a very large number of sub-jobs running on most of the grid systems for an application that will be repeatedly run, the data they use may be copied to each machine and reside until the next time the application runs. This is preferable to using a networked file system to share this data, because in such a file system, the data would be effectively moved from a central location every time the application is run. This type of analysis is necessary for large jobs to better utilize the grid and not create unnecessary bottlenecks.*
- *Monitoring progress and recovery: The user can query the grid system to see how his application and its sub-jobs are progressing. When the number of sub-jobs becomes large, it becomes too difficult to list them all in a graphical window. Instead, there may simply be one large bar graph showing some averaged progress metric. It becomes more difficult for the user to tell if any particular sub-job is not running properly. A grid system, in conjunction with its job scheduler, often provides some degree of recovery for sub-jobs that*

*fail. A job may fail due to a Programming error, Hardware or power failure, Communications interruption, and Excessive slowness due to infinite loop or some other form of contention.*

- ***Reserving resources**: To improve the quality of a service, the user may arrange to reserve a set of resources in advance for his exclusive or high-priority use. Such a reservation system can also be used in conjunction with planned hardware or software maintenance events, when the affected resource might not be available for grid use*

*(iv) Using a Grid: An Administrative Perspective*

- ***Planning:** The administrator should understand the organization's requirements for the grid to better choose the grid technologies that satisfy grid's requirements. One of the first considerations is the hardware available and how it is connected via a LAN or WAN. Next, an organization may want to add additional hardware to supplement the capabilities of the grid.*
  - ***Security**: Security is a much more important factor in planning and maintaining a grid where data sharing comprises the bulk of the activity. In a grid, the member machines are configured to execute programs rather than just move data. This makes an unsecured grid potentially fertile ground for viruses and Trojan horse programs. For this reason, it is important to understand the issues involved in authenticating users and providing proper authorization for specific operations.*
  - ***Organization**: It is important to understand how the departments in an organization interact, operate, and contribute to the whole. Often, there are barriers built between departments and projects to protect their resources in an effort to increase the probability of timely success. For example, a project that finds itself behind schedule and over budget may not be able to afford the resources required to solve the problem. A grid would give such projects an added measure of safety, providing an extra margin of resource.*
- ***Installation**: First, the selected grid system must be installed on an appropriately configured set of machines. These machines should be connected using networks with sufficient bandwidth to other machines on the grid. Machines should be configured and connected to facilitate recovery scenarios. Any critical databases or other data essential for keeping track of the jobs in the grid, members of the grid, and machines on the grid should have suitable backups.*
- ***Managing enrollment of donors and users**: The administrator is responsible for controlling the rights of the users in the grid. Donor machines may have access rights that require management as well.. The rights of these grid user*

*IDs must be properly set so that grid jobs do not allow access to parts of the donor machine to which the users are not entitled. As users join the grid, their identity must be positively established and entered in the Certificate Authority. Further, procedures for removing users and machines must also be executed by the administrator.*

- *<u>Certificate Authority</u>: It is critical to ensure the highest levels of security in a grid because the grid is designed to execute code and not just share data. Thus, viruses, Trojan horses, and other attacks cane affect the grid system. The Certificate Authority is one of the most important aspects of maintaining strong grid security. An organization may choose to use an external Certificate Authority or operate one itself. The primary responsibilities of a Certificate Authority are:*
    - *Positively identifying entities requesting certificates;*
    - *Issuing, removing, and archiving certificates;*
    - *Protecting the Certificate Authority server;*
    - *Maintaining a namespace of unique names for certificate owners;*
    - *Serving signed certificates to those needing to authenticate entities; and*
    - *Logging activity.*
- *<u>Resource Management</u>: Another responsibility of the administrator is to manage the resources of the grid. This includes setting permissions for grid users to use the resources as well as tracking resource usage and implementing a corresponding accounting or billing system. Usage statistics are useful in identifying trends in an organization that may require the acquisition of additional hardware; reduction in excess hardware to reduce costs; and adjustments in priorities and policies to achieve better for attaining the overall goals of an organization etc.*
- *<u>Data sharing</u>: For small grids, the sharing of data can be fairly easy, using existing networked file systems, databases, or standard data transfer protocols. As a grid grows and the users become dependent on any of the data storage repositories, the administrator should consider procedures to maintain backup copies and replicas to improve performance. All of the resource management concerns apply to data on the grid.*

*(v) <u>Application Areas of Grid Computing</u>*

- *Civil engineers collaborate to design, execute, & analyze shake table experiments.*
- *An insurance company mines data from partner hospitals for fraud detection.*

- *An application service provider offloads excess load to a compute cycle provider.*
- *An enterprise configures internal & external resources to support e-Business workload.*
- *Large-scale science and engineering are done through the interaction of people, heterogeneous computing resources, information systems and instruments, all of which are geographically and organizationally dispersed.*

*(vi) Grid Computing Security*

*Grid systems and applications require standard security functions which are Authentication, Access Control, Integrity, Privacy, and No Repudiation. Authentication and access control issues are:*

- *To provide authentication to verify the users, process which have user's computation and resources used by the processes to authenticate*
- *To allow local access control mechanisms to be used without change.*

*To develop security architecture, following constraints are taken from the characteristics of grid environment and application.*

- *Single Sign-on: A user should authenticate once and they should be able to acquire resources, use them, and release them and to communicate internally without any further authentication.*
- *Protection of Credentials: User passwords, private keys, etc. should be protected.*
- *Interoperability with local security solutions: Access to local resources should have local security policy at a local level. Despite of modifying every local resource there is an inter-domain security server for providing security to local resource.*
- *Exportability: The code should be exportable i.e. they cannot use a large amount of encryption at a time. There should be a minimum communication at a time.*
- *Support for secure group communication: In a communication there are number of processes which coordinate their activities. This coordination must be secure and for this there is no such security policy.*
- *Support for multiple implementations: There should be a security policy which should provide security to multiple sources based on public and private key cryptography.*

### 5.7.3 Cloud Computing

*A detailed discussion on Cloud Computing, its architecture and Service Models has already been introduced in Chapter -2 "Information Systems and IT Fundamentals" of the Study Material of Intermediate (IPC) Course. However, an overview of Cloud Computing is again provided here.*

As already explained, Cloud Computing is the use of various services, such as software development platforms, servers, storage, and software, over the different networks, often referred to as the "cloud."

Many cloud computing advancements are closely related to virtualization. The ability to pay on-demand and scale quickly is largely a result of cloud computing vendors being able to pool resources that may be divided among multiple clients.

#### (i) Characteristics of Cloud Computing

The following is a list of characteristics of a cloud-computing environment. Not all characteristics may be present in a specific cloud solution. However, some of the key characteristics are given as follows:

- **Elasticity and Scalability:** Cloud computing gives us the ability to expand and reduce resources according to the specific service requirement. For example, we may need a large number of server resources for the duration of a specific task. We can then release these server resources after we complete our task.
- **Pay-per-Use:** We pay for cloud services only when we use them, either for the short term (for example, for CPU time) or for a longer duration (for example, for cloud-based storage or vault services).
- **On-demand:** Because we invoke cloud services only when we need them, they are not permanent parts of the IT infrastructure. This is a significant advantage for cloud use as opposed to internal IT services. With cloud services there is no need to have dedicated resources waiting to be used, as is the case with internal services.
- **Resiliency:** The resiliency of a cloud service offering can completely isolate the failure of server and storage resources from cloud users. Work is migrated to a different physical resource in the cloud with or without user awareness and intervention.
- **Multi Tenancy:** Public cloud service providers often can host the cloud services for multiple users within the same infrastructure. Server and storage isolation may be physical or virtual depending upon the specific user requirements.
- **Workload Movement:** This characteristic is related to resiliency and cost considerations. Here, cloud-computing providers can migrate workloads across servers both inside the data center and across data centers (even in a different geographic area). This migration might be necessitated by cost (less expensive to run a workload in a data center in another country based on time of day or power requirements) or efficiency considerations

(for example, network bandwidth). A third reason could be regulatory considerations for certain types of workloads.

### (ii) Cloud Service Models

*Although Cloud Service Models (SaaS, PaaS, NaaS, CaaS and IaaS) have already been discussed in Chapter – 2 "Information Systems and IT Fundamentals" of the Study Material; we shall here again discuss the common Cloud Computing Service Models - Software as a Service (SaaS), Platform as a Service (PaaS) or Infrastructure as a Service (IaaS), as shown in Fig. 5.7.2.*

- **Software as a Service (SaaS):** SaaS features a complete application offered as a service on-demand. A service provider hosts the application at its data centre over the Internet and customer accesses it via a standard Web browser. For example, Google Apps.
- **Platform as a Service (PaaS):** PaaS delivery model allows a customer to rent virtualized servers and associated services used to run existing applications, or to design, develop, test, deploy and host applications. The consumer may create software using tools and/or libraries from the provider. The consumer may also control software deployment and configuration settings. The provider provides the networks, servers, storage, and other services. For example, AppScale allows a user to deploy some applications written for Google App Engine to their own servers.
- **Infrastructure as a Service (IaaS):** IaaS delivers computer infrastructure on an outsourced basis to support enterprise operations. Typically, IaaS provides hardware, storage, servers and data centre space or network components; it may also include software.

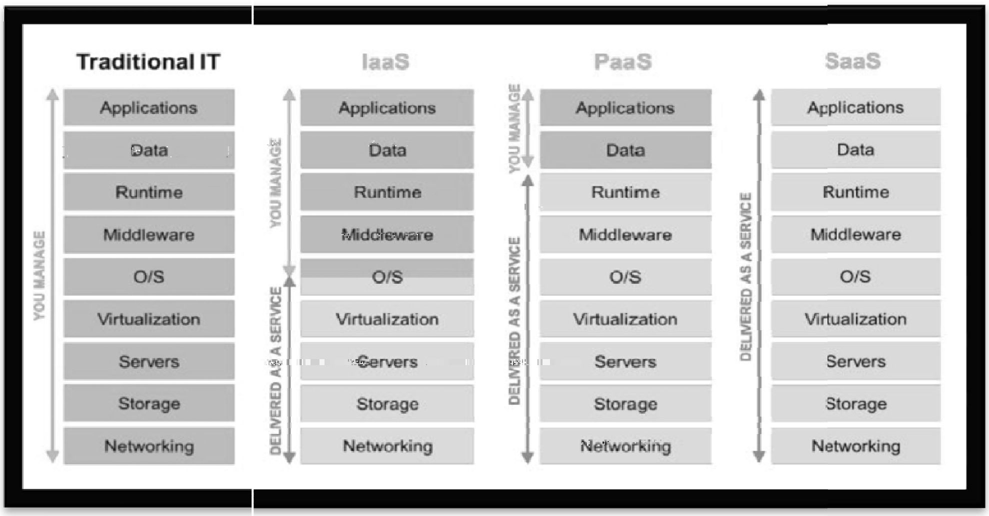


**Fig. 5.7.2: Cloud Service Models**

### (iii) Advantages of Cloud Computing

If used properly and to the extent necessary, working with data in the cloud can vastly benefit all types of businesses. Mentioned below are some of the advantages of this technology:

- **Cost Efficient:** Cloud computing is probably the most cost efficient method to use, maintain and upgrade.
- **Almost Unlimited Storage:** Storing information in the cloud gives us almost unlimited storage capacity.
- **Backup and Recovery:** Since all the data is stored in the cloud, backing it up and restoring the same is relatively much easier than storing the same on a physical device. Furthermore, most cloud service providers are usually competent enough to handle recovery of information.
- **Automatic Software Integration:** In the cloud, software integration is usually something that occurs automatically. Not only that, cloud computing allows us to customize the options with great ease. Hence, we can handpick just those services and software applications that we think will best suit the particular enterprise.
- **Easy Access to Information:** Once we register ourselves in the cloud, we can access the information from anywhere, where there is an Internet connection.
- **Quick Deployment:** Once we opt for this method of functioning, the entire system can be fully functional in a matter of a few minutes. Of course, the amount of time taken here will depend on the exact kind of technology that we need for our business.

### (iv) Disadvantages of Cloud Computing

In spite of its many benefits, as mentioned above, cloud computing also has its disadvantages. Businesses, especially smaller ones, need to be aware of these cons before going in for this technology. Major disadvantages are given as follows:

- **Technical Issues:** This technology is always prone to outages and other technical issues. Even the best cloud service providers run into this kind of trouble, in spite of keeping up high standards of maintenance. We will invariably be stuck in case of network and connectivity problems.
- **Security in the Cloud:** Surrendering all the company's sensitive information to a third-party cloud service provider could potentially put the company to great risk.
- **Prone to Attack:** Storing information in the cloud could make the company vulnerable to external hack attacks and threats. Nothing on the Internet is completely secure and hence, there is always the lurking possibility of stealth of sensitive data.

## 5.8 Summary

Most of the enterprises processes are now automated whether they are in the private or public sector or government. Enterprises are increasingly relying on IT in all key areas. The profitability and the future viability of enterprises increasingly depend on the continued functioning of IT systems. Without them, there is often doubt if a company will survive. These IT systems also represent a considerable proportion of any company's capital budget. The emphasis of chapter has been to update students with the latest developments in technology. These developments have been happening through automations, delivery channels being changed with extensive use of emerging technologies such as cloud computing, mobile computing, BI, etc.

The first part of chapter discusses about business applications. The business applications can be used for varied business functions such as accounting, payroll, purchases, sales, etc. The chapter helps students to understand the importance of software applications to business. The second part is in continuation to the discussion of the part I. It deals with the Business Process Automation, which is a word used in businesses across the world. The chapter helps students to understand the nature and impact of business automation on businesses. It also gives thought to what-if, no automation is made.

The next part of the chapter deals with Information Processing and Delivery channels. The chapter highlights the way businesses have been modified due to change in delivery channels. An updated discussion on latest trend in consumer behavior vis-à-vis technology adoption is there in the chapter. The business impact due to change in delivery channel is also discussed in the chapter with live examples.

Application controls, discussed in the chapter shall help student to understand the nature of control and why they are needed in business. Controls are important for survival of any good business process. If an entity creates business process automation and does not properly control the same, it shall spell disaster for business. This section highlights this aspect of the business.

The last part of the chapter deals with emerging technologies namely virtualization, grid computing and cloud computing. The objective of this section is to give brief overview of the technology as it is used and the benefits the society is getting from it. The best word to define these technologies is “social technologies”.

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*Note:* Students, who wish to pursue advance study of the subject, are advised to read the aforementioned books in detail and also refer websites for more thorough information.

# Glossary

## A

**Analytical CRM:** Customer relationship management applications dealing with the analysis of customer data to provide information for improving business performance.

**Android:** Android is a Linux-based operating system designed primarily for touch screen mobile devices such as smart phones and tablet computers.

**Application Program Interface (API):** The specific method prescribed by a computer operating system or by an application program by which a programmer writing an application program can make requests of the operating system or another application

**Application Service Provider (ASP):** Company providing software that can be rented by other companies over the Web or a private network.

**Application Software Package:** A set of prewritten, precoded application software programs that are commercially available for sale or lease.

**Artificial Intelligence (AI):** The effort to develop computer-based systems that can behave like humans, with the ability to learn languages, accomplish physical tasks, use a perceptual apparatus, and emulate human expertise and decision making.

**Asynchronous Transfer Mode (ATM):** A networking technology that parcels information into 8-byte cells, allowing data to be transmitted between computers from different vendors at any speed.

## B

**Bandwidth:** The capacity of a communications channel as measured by the difference between the highest and lowest frequencies that can be transmitted by that channel.

**Best Business Practices:** It must have a collection of the best business processes applicable worldwide. And IT package imposes its own logic on a company's strategy, culture and organization.

**Beyond The Company:** It should not be confined to the organizational boundaries, rather support the on-line connectivity to the other business entities of the organization.

**Blocking:** a process preventing the transfer of a specified amount of funds or a specified quantity of a security.

**Bluetooth:** Bluetooth is a wireless technology standard for exchanging data over short distances up to 50 meters (164 feet) from fixed and mobile devices, creating Personal Area Networks (PANs) with high levels of security. It is a feature which is used every day through a number of compatible devices.

**BPM lifecycle:** It is a generic process optimization methodology defined explicitly for business processes. It provides a high level approach from a phased perspective without prescribing specific techniques such as those found in Six Sigma or Lean.

**Business Process Automation (BPA):** Removing the human element from existing business processes by automating the repetitive or standardized process components.

**Business Process Management (BPM):** The methodology used by enterprises to improve end-to-end business processes.

**Business Process Management:** Business Process Management (BPM) is the methodology used by enterprises to improve end-to-end business processes in five stages namely: design, modeling, execution, monitoring and optimization.

**Business Process Re-engineering (BPR):** It can be defined as the search for, and implementation of, radical change in business processes to achieve breakthrough improvements in products and services.

**Business Processes:** The unique ways in which organizations coordinate and organize work activities, information, and knowledge to produce a product or service.

**Business-To-Business (B2B) electronic commerce:** Electronic sales of goods and services among businesses.

**Business-To-Consumer (B2C) electronic commerce:** Electronic retailing of products and services directly to individual consumers.

# C

**Cache Memory:** It is a memory that lies in the path between the processor and the RAM, which a computer microprocessor can access more quickly than it can access regular RAM.

**Card (payment card):** A device that can be used by its holder to pay for goods and services or to withdraw money.

**Cellular Phone System:** A radio communications technology that divides a metropolitan area into a honeycomb of cells to greatly increase the number of frequencies and thus the users that can take advantage of mobile phone service.

**Central Processing Unit (CPU):** The brain of the computer, is the actual hardware that interprets and executes the program instructions and coordinates how all the other hardware devices work together.

**Client/Server Networks:** A computing environment where end user workstations (clients) are connected to micro or mini LAN (servers) or possibly to a mainframe (super server).

**Cloud Computing:** A type of computing, comparable to grid computing that relies on sharing computing resources rather than having local servers or personal devices to handle applications, involves delivering hosted services over the Internet.

**Coaxial Cable:** A sturdy copper or aluminium wire wrapped with spacers to insulate and protect it. Groups of coaxial cables may be bundled together in a bigger cable for ease of installation.

**Communications Satellites:** Earth satellites placed in stationary orbits above the equator that serve as relay stations for communications signals transmitted from earth stations.

**Computer Network:** A collection of computers and other hardware interconnected by communication channels that allow sharing of resources and information.

**Customer Relationship Management Systems:** Information systems that track all the ways in which a company interacts with its customers and analyze these interactions to optimize revenue, profitability, customer satisfaction, and customer retention.

**Customization:** The modification of a software package to meet an organization's unique requirements without destroying the package software's integrity.

# D

**Data Base Management Systems (DBMS):** Software that aid in organizing, controlling and using the data needed by the application programme.

**Data Logging:** Recording of all data generated by a device, or the data passing through a particular point in a networked computer System.

**Database Model**: A type of data model that determines the logical structure of a database and fundamentally determines in which manner data can be stored, organized, and manipulated.

**Decision-Support Systems (DSS):** Information systems at the organization's management level that combine data and sophisticated analytical models or data analysis tools to support semi structured and unstructured decision making.

**Downsizing:** Moving to smaller computing platforms, such as from mainframe systems to networks of personal computers and servers.

# E

**Electronic Business (E-business):** The use of the Internet and digital technology to execute all the business processes in the enterprise. Includes e-commerce as well as processes for the internal management of the firm and for coordination with suppliers and other business partners.

**Electronic Commerce Server Software:** Software that provides functions essential for running e-commerce Web sites, such as setting up electronic catalogs and storefronts, and mechanisms for processing customer purchases.

**Electronic Commerce:** The process of buying and selling goods and services electronically involving transactions using the Internet, networks, and other digital technologies.

**Electronic Data Interchange (EDI):** The direct computer-to-computer exchange between two organizations of standard business transaction documents.

**Electronic Mail (e-mail):** The computer-to-computer exchange of messages.

**Enterprise Application Integration (EAI) software:** Software that works with specific software platforms to tie together multiple applications to support enterprise integration.

**Enterprise Networking:** An arrangement of the organization's hardware, software, network, and data resources to put more computing power on the desktop and create a company-wide network linking many smaller networks.

**Enterprise Portal:** Web interface providing a single entry point for accessing organizational information and services, including information from various enterprise applications and in-house legacy systems so that information appears to be coming from a single source.

**Enterprise Software:** Set of integrated modules for applications such as sales and distribution, financial accounting, investment management, materials management, production planning, plant maintenance, and human resources that allow data to be used by multiple functions and business processes.

**Enterprise Systems:** Integrated enterprise-wide information systems that coordinate key internal processes of the firm.

**ERP:** It is business management software that allows an organization to use a system of integrated applications to manage the business.

**Extranets:** A network that links selected resources of the intranet of a company with its customers, suppliers, and other business partners, using the Internet or private networks to link the organizations' intranets.

# F

**Fiber optics:** The technology that uses cables consisting of very thin filaments of glass fibers that can conduct the light generated by laser at frequencies that approach the speed of light.

**Flexibility:** An IT system should be flexible to respond to the changing needs of an enterprise. The client server technology enables IT to run across various database back ends through Open Database Connectivity (ODBC).

# I

**Information technology (IT):** Any computer-based tool that people use to work with information and support the information and information-processing needs of an enterprise.

**Instruction Set Architecture (ISA):** It is the abstract model of a computing system that is seen by a machine language programmer, including the instruction set, memory address modes, processor registers, and address and data formats.

**Internet Technologies:** The Internet and its technologies are being used to build interconnected enterprises and global networks, like intranets and extranets that form information superhighways to support enterprise collaboration, electronic commerce, and internal business applications.

**Internetwork Processors:** Internetwork processors such as bridges, routers, hubs, or gateways to other LANs or wide area networks interconnect many LANs.

**Intranets:** Open, secure Internet-like networks within organizations.

# K

**Knowledge Management:** The set of processes developed in an organization to create, gather, store, maintain, and disseminate the firm's knowledge.

**Knowledge Management Systems:** Systems that support the creation, capture, storage, and dissemination of firm expertise and knowledge.

# L

**Legacy Systems:** The older, traditional mainframe-based business information systems of an organization.

**Local Area Network (LAN):** A communications network that typically connects computers, terminals, and other computerized devices within a limited physical area such as an office, building, manufacturing plant, or other work site.

# M

**Management Information Systems (MIS):** The study of information systems focusing on their use in business and management.

**Metadata:** Metadata (meta-content) are defined as the data providing information about one or more aspects of the data.

**Micro architecture**: It is a term used to describe the resources and methods used to achieve architecture specification.

**MIS (Management Information Systems):** It is a general term for the computer systems in an enterprise that provide information about its business operations. It's also used to refer to the people who manage these systems.

**Mobile Computing:** It is a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device without having to be connected to a fixed physical link.

**Modem (MOdulation - DEModulation):** A device that converts the digital signals from input/output devices into appropriate frequencies at a transmission terminal and converts them back into digital signals at a receiving terminal.

**Multiplexer:** An electronic device that allows a single communications channel to carry simultaneous data transmissions from many terminals.

# N

**Network Architectures – OSI:** The International Standards Organization (ISO) has developed a seven-layer Open Systems Interconnection (OSI) to serve as a standard model for network architectures in order to promote an open, simple, flexible, and efficient telecommunications environment.

**Network Architectures - TCP/IP:** The Internet's protocol suite is called Transmission Control Protocol/Internet Protocol (TCP/IP). TCP/IP consists of five levels of protocols that can be related to the seven layers of the OSI architecture. TCP/IP is used by the Internet and all intranets and extranets.

**Network Computing:** A network-centric view of computing in which "the network is the computer," that is, the view that computer networks are the central computing resource of any computing environment.

**Network Operating System:** A network operating system is a program that is used to control telecommunications and the use of and sharing of network resources.

**Network Server:** LANs use a powerful microcomputer with a large disk capacity as a file server or network server. The server handles resource sharing and telecommunications.

# O

**OLAP:** Online Analytical Processing: is a multi-dimensional analytical tool typically used in data mining, that gathers and process vast amounts of information into useful packets.

**Open Systems:** Model of network protocols enabling any computer connected to a network to communicate with any other computer on the same network or a different network, regardless of the manufacturer.

**Operating System (OS):** A set of computer programs that manages computer hardware resources and acts as an interface with computer applications programs.

**Operating System Software**: An operating system (OS) Software is a set of computer programs that manages computer hardware resources and acts as an interface with computer applications programs. The operating system is a vital component of the system software in a computer system.

# P

**Peer-to-Peer Networks (P2P):** Computing environments where end user computers connect, communicate, and collaborate directly with each other via the Internet or other telecommunications network links.

**Protocol:** A set of rules and procedures for the control of communications in a communication network.

# R

**Radical Redesign:** This means getting down to the fundamental – where necessary throwing away the old, out of date rules – and recognizing that quality and innovation are more important to profit than cost.

**Random Access Memory (RAM):** It is the Short term Memory in a computer where the operating system, application programs, and data in current use are kept so that they can be quickly reached by the computer's CPU.

**Read Only Memory (ROM)**: It is computer memory containing data that normally can only be read, not written to, usually used by manufacturers.

**Re-engineering:** It is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed.

**Register**: It is one of a small set of data holding places (memory) that are part of a central Processing unit (CPU).

**Routing**: Refers to the process of deciding on how to communicate the data from source to destination, in a network.

# S

**Scalability:** scalability is the ability of a system, network, or process to handle a growing amount of work in a capable manner or its ability to be enlarged to accommodate that growth.

**Server (Client-Server Architecture):** It is a computer program running to serve the requests of other programs, the "clients".

**Server (Hardware):** It is a device on a network dedicated to run one or more services (as a host), to serve the needs of the users of other computers on a network.

**Smartphone:** It is a mobile phone built on a mobile operating system, with more advanced computing capability connectivity than a feature phone.

**Software as a Service (SaaS):** A software delivery method that provides access to software and its functions remotely as a Web-based service.

**System flowchart:** A tool for documenting a physical system in which each component is represented by a symbol that visually suggests its function.

**System Software:** A computer software that is designed to operate the computer hardware and to give and maintain a platform for running application software.

**Systems Development Life Cycle (SDLC):** It is a conceptual model used in project management that describes the stages involved in an information system development project, from an initial feasibility study through maintenance of the completed application.

# T

**Tablet:** It is a one piece general-purpose computer contained in a single panel. Its distinguishing characteristic is the use of a touch screen as the input device.

**Telecommunications Channels:** Telecommunications channels are the part of a telecommunications network that connects the message source with the message receiver. It includes the physical equipment used to connect one location to another for the purpose of transmitting and receiving information.

**Telecommunications Media:** Telecommunications media are the physical media used by telecommunications channels. They include, twisted- pair wire, coaxial cables, fiber optic cables, terrestrial microwave, communications satellite, cellular, and infrared systems.

**Telecommunications Network Components:** Telecommunications components include terminals, telecommunications processors, telecommunications channels and media, computers, and telecommunications control software.

**Telecommunications Processors:** Multiplexers, concentrators, communications controllers, and cluster controllers that allow a communications channel to carry simultaneous data transmissions from many terminals. They may also perform error monitoring, diagnostics and correction, modulation-demodulation, data compression, data coding and decoding, message switching, port contention, and buffer storage.

**Telecommunications Software:** Telecommunications software, including network operating systems, telecommunications monitors, web browsers, and middleware, control and support the communications activity in a telecommunications network.

**Touchpad:** A touchpad is a pointing device featuring a tactile sensor, a specialized surface that can translate the motion and position of a user's fingers to a relative position on screen.

**Transaction Processing Systems (TPS):** Computerized systems that perform and record the daily routine transactions necessary to conduct the business; they serve the organization's operational level.

# V

**Virtual Memory:** It is an allocation of hard disk space to help RAM. Virtual memory combines computer's RAM with temporary space on the hard disk.

**Virtual Organization:** Organization using networks to link people, assets and ideas to create and distribute products and services without being limited to traditional organizational boundaries or physical location.

**Virtual Private Network:** A secure network that uses the Internet as its main backbone network to connect the intranets of a company's different locations or to establish extranet links between a company and its customers, suppliers, or other business partners.

**Virtualization:** Virtualization is the creation of a virtual (rather than actual) version of something, such as an operating system, a server, a storage device or network resources.

# W

**Wide Area Network (WAN):** A data communications network covering, a large geographic area.

**Wi-Fi:** It is the name of a popular wireless networking technology that uses radio waves to provide wireless high-speed Internet and network connections. Wi-Fi networks have limited range.

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